DESIGN-BUILD CONTRACTING FOR HIGHWAY CONSTRUCTION PROJECTS IN TEXAS

A Final Report
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Submitted to:

Texas Department of Transportation

September 1997

Research Study No: 7-3916
Report No. TX-97/7-3916-1F

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The "Turn Key Construction" project involves the development of a statistically based specification for the procurement of low volume highway projects using the Design-Build (DB) method of contracting. This project originally intended to develop current DB procurement techniques to a point which would permit contract award on a lowest and best bid basis. However, during the course of the study it was found that current state law prohibits the use of DB for public projects. Midway through the study, its focus was shifted to developing a set of guidelines and specifications which would permit the speedy implementation of DB, if and when it became permitted through new legislation. The study finds that 15 state departments of transportation are currently using DB for highway construction projects and that it could be successfully implemented in Texas through enabling legislation. The study also developed three alternative methods for DB contract award which can be applied to individual project requirements. It also recommends that DB be considered merely another procurement tool and not a total replacement for current low bid construction contract awards.

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IMPLEMENTATION STATEMENT

At this point in time, it is impossible to implement this work due to legal restrictions which are detailed in the Final Report. In short, legislation much be introduced to permit the implementation of Design-Build contracting in TxDOT. The documents developed in this project can be held until the necessary enabling legislation is passed, and then used as a basis to start the implementation process.

Dissemination of this information will best be accomplished through the Construction and Maintenance Division. A policy document which outlines the requirements for the implementation of Design-Build contracting should be published and disseminated to all districts. Other procurement regulations will require modification once this project delivery method is made legal by enabling legislation.

DISCLAIMER

The contents of this report reflect the views of the authors, who are solely responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

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Table of Contents

List of Tables

List of Figures

Final Report: TxDOT Project 7-3916; "Design-Build Contracting for Highway Construction in Texas."

PROJECT ABSTRACT

The "Turn Key Construction" project involves the development of a statistically based specification for the procurement of low volume highway projects using the Design-Build (DB) method of contracting. This project originally intended develop current DB procurement techniques to a point which would permit contract award on a lowest and best bid basis. However, during the course of the study it was found that current state law prohibits the use of DB for public projects. Midway through the study, its focus was shifted to developing a set of guidelines and specifications which would permit the speedy implementation of DB if and when it became permitted through new legislation. The study finds that 15 state departments of transportation are currently using DB for highway construction projects and that it could be successfully implemented in Texas through enabling legislation. The study also developed three alternative methods for DB contract award which can be applied to individual project requirements. The study recommends that DB be considered only another procurement tool and not a total replacement for current low bid construction contract awards.

"Design-Build in the public education sector is an excellent first step in bringing proven delivery methods for engineering services into the public sector without sacrificing public safety."
John R. Speed, P.E., Executive Director, Texas Board of Professional Engineers, (P.E. Newsletter, July,1997)

INTRODUCTION

In the past decade, public agencies around the nation have been examining their procurement processes to identify regulatory restrictions which are unnecessarily constraining the procurement system and adding needless cost and time to the development and delivery of needed public facilities. These agencies have commonly employed techniques that spring from the tenets of Total Quality Management (TQM) (Walton, 1986). Some of these efforts have been called "Reinventing Government" (Gaebler and Osborne, 1993) or "Continuous Improvement" (Walton, 1986). Regardless of the slogans and buzz words, the heart and soul of the effort is to develop realistic, legally defensible procurement policies and methods which eliminate redundant review requirements and permit public agencies to deliver required facilities as quickly as possible and at the lowest possible cost. In transportation projects, these "new" methods have been classified by the Federal Highway Administration (FWHA, 1995) as innovative contracting methods. One such method is Turn Key contracting for highway construction.

The Turn Key (hereafter referred to as Design-Build or DB) method of construction contracting is becoming prevalent for use in the United States. In the twelve month period ending in December 1996, nearly $16 billion worth of projects were procured using this method. Of these, about $10.2 billion were completed by public agencies, and of that amount nearly 35 percent

were transportation projects (DBIA, 1996). Transportation was the largest single public sector market for DB contracting. The literature clearly documents potential savings in both time and initial cost when this method is used instead of the traditional design-bid-build (DBB) method (Ellis, et al, 1991). These savings are accrued from many aspects of the process from being able to start construction before design is complete to utilizing a best value rather than a low bid basis of contract award (Ellicott, 1994).

However, to achieve these benefits a public agency like the Texas Department of Transportation (TxDOT) with a long history of successful DBB contracts must undergo a serious paradigm shift. First, legislation must be introduced which permits the use of innovative contracting methods. Once the law is changed, internal procurement policy must be altered to capitalize on the potential benefits offered by the innovation. This will not be easy. Not only must the agency surrender time-worn attitudes and policies regarding competitively bid contracts, but it must also develop a method to objectively evaluate the subjective differences between competing offerors. This shift forces the institution to use the maximum latitude available within its policies and regulations and to become creative in its approach to evaluate contractual risk while ensuring fair and open competition. Additionally, TxDOT will want to ensure that new policies are not overly restrictive and that they allow the requisite amount of flexibility at the district and field office level to tailor individual procurement packages to the individual needs of each individual project. The key element of this type of system is the creation of a proposal evaluation system which is based on a fair and equitable methodology to objectively evaluate competing proposals on parameters other than price. Utility theory or some similar approach offers a structure on which to build such an evaluation system (FWHA, 1996, Gransberg, 1995, Dozzi, et al, 1995).

Design-Build Use in Other Agencies

This study, seeking to identify a cogent set of DB best practices, focused on finding examples of how other public agencies made the transition from DBB to DB. As a result, the study sought input from DB programs in other state departments of transportation (DOTs) and the Federal government and evaluated their applicability to the Texas Department of Transportation. This was done by surveying all the DOTs and five federal agencies. Thirty-three DOTs responded, and it was determined that fifteen states are currently using DB as an approved transportation project procurement method. On the federal level, the Department of Defense is using DB extensively and believes that significant savings in both cost and time can be accrued through its use. Currently, FHWA only permits the use of DB on projects with federal funds contribution which are approved for inclusion in FWHA Special Experimental Project No. 14 (SEP 14) (FHWA, 1996). Functionally, it is very easy for states who wish to utilize DB on federally funded projects to gain inclusion in SEP14. However, it requires an additional amount of paperwork and front-end administrative time.

An evaluation of the documentation that was obtained on the state and federal level DB programs showed that the programs in use by Arizona (Arizona, 1996), Colorado (Colorado, 1996), Florida (Florida, 1997), Pennsylvania (Pennsylvania, 1995), and the U.S. Army Corps of Engineers (USACE, 1994, FAR, 1997) were the most mature. Florida in particular has been using DB since 1983, and as a result Florida has the most well developed set of guidelines and procedures

for implementing DB on transportation projects. The Corps of Engineers also has more than a decade of DB experience, but most of the experience is with building projects. Consequently, it was decided to use the Florida guidelines as a model for format and organization and select the best and most logical portions from Arizona, Colorado, Florida, Pennsylvania, and the Corps to develop the content of the recommended DB guidelines.

The study specifically focused on applying DB to highway construction projects and used that type of project as the basis to develop technical requirements for inclusion in the research project's deliverables. There was also a wealth of information on other types of DB projects, and it was determined to make the recommended DB specifications and guidelines as broad as possible to capitalize on the knowledge gained during this research. If and when DB becomes a legal procurement method, guidance will be provided for further implementation.

Technical Design Requirements

To properly apply DB to a particular project, one must first thoroughly understand the technical requirements of that project. In highway construction the pavement structure is the primary technical design and construction challenge. Therefore, before an evaluation plan for a highway DB contact can be built, the engineer must first analyze the technical requirements inherent to the pavement. In pavement design and construction TxDOT currently uses a system where TxDOT personnel perform pavement design and receive bids on their final design from construction contractors. The bidder with the lowest and the best bid is awarded the contract (this process will be hereafter referred to as Design-Bid-Build or DBB). When the construction is complete and the contractor has proven that the constructed pavement meets certain acceptance criteria, TxDOT takes over the completed project. Once TxDOT accepts the project, they also accept full responsibility of maintaining the pavement to provide its intended function. The current TxDOT pavement design methodology for new pavements is an automated system where the FPS-19 computer program aids the TxDOT pavement designers to arrive at a design that would satisfy the design requirements. These design requirements are:

- Design life of pavement
- Traffic volume
- Geometrics
- Reliability

The required types of design parameters are indicated below.

- Trial pavement layer configuration
- Trial pavement layer thickness
- Climatic conditions
- Material properties

For the design of pavement rehabilitation projects, data on pavement performance such as distress data and structural condition data are also available for the pavement designer.

The current TxDOT pavement design provides the lowest life-cycle cost for all candidate designs to be evaluated. The design procedure incorporates pavement distress prediction models for each significant form of distress. The design methodology is based on statistical methods incorporating a reliability level for the pavement structure. This level of reliability is governed by the reliability of available data, distress prediction models and the functional classification of the pavement.

Once a pavement is constructed, TxDOT accepts the project only if the construction meets specified acceptance criteria. These acceptance criteria currently include pavement layer thickness and pavement ride quality. The quality of materials used by the contractor is currently monitored under TxDOT Standard Specifications for Construction of Highways, Streets and Bridges (TxDOT, 1993) and the TxDOT Manual of Testing Procedures (TxDOT, 1994).

REVIEW OF PREVIOUS WORK

The U. S. Congress recognized the value of institutionalizing nontraditional procurement methods and directed the Department of Defense to expand their uses (Procedures, 1990). Design-Build's (DB) single biggest advantage is that it provides a single point of responsibility for the owner on all a project's technical aspects (Fisk, 1992). The construction contractor and the designer can no longer point fingers at each other when something goes awry. With Design-Build, the contractor and the designer are one in the same. This opens a new avenue for project risk management. Because the contractor is liable for both design and final product, the project can start construction without a completed design. In fact, because the designer is also the builder, a 100% detailed design may not be required to complete a high quality project (Gransberg and Bell, 1996). The other advantages of DB (Barrie, 1978) are listed below.

- Single contract to administer
- Interdisciplinary process knowledge combined with interdisciplinary design expertise
- Minimal coordination between major project elements
- Adaptable to phased construction to reduce project delivery time
- Simplified change order process
- Increased construction efficiency (Tenah and Guevara, 1985)

The remainder of the salient information found in this study is detailed in the section titled Task 1, Literature Review.

RESEARCH APPROACH/PROCEDURES

The project has two separate and distinct types of tasks. The first are those associated with the development and fielding of the DB contract including the review of current State law regarding this type of procurement. The second group are those associated with the development of the statistically based pavement design and construction specification itself. Work in these two areas proceed in parallel. The work accomplished is summarized by the proposal task number in the following paragraphs.

Task 1, Literature Review

A comprehensive review of the literature regarding Design-Build was made to identify the state-of-the-art in the use of this method for public project procurement. Special attention was paid to types and content of contracts which attempt to award projects on a low and/or best bid basis. Current state and federal guide specifications and contract boilerplate were reviewed to find "tried and true" examples of contract language which has been successfully used to procure transportation facilities. Additionally, detailed research was made into the requirements for the bonding of Texas contractors on highway projects and the impact of construction guarantees and warrantees on company bonding capacity.

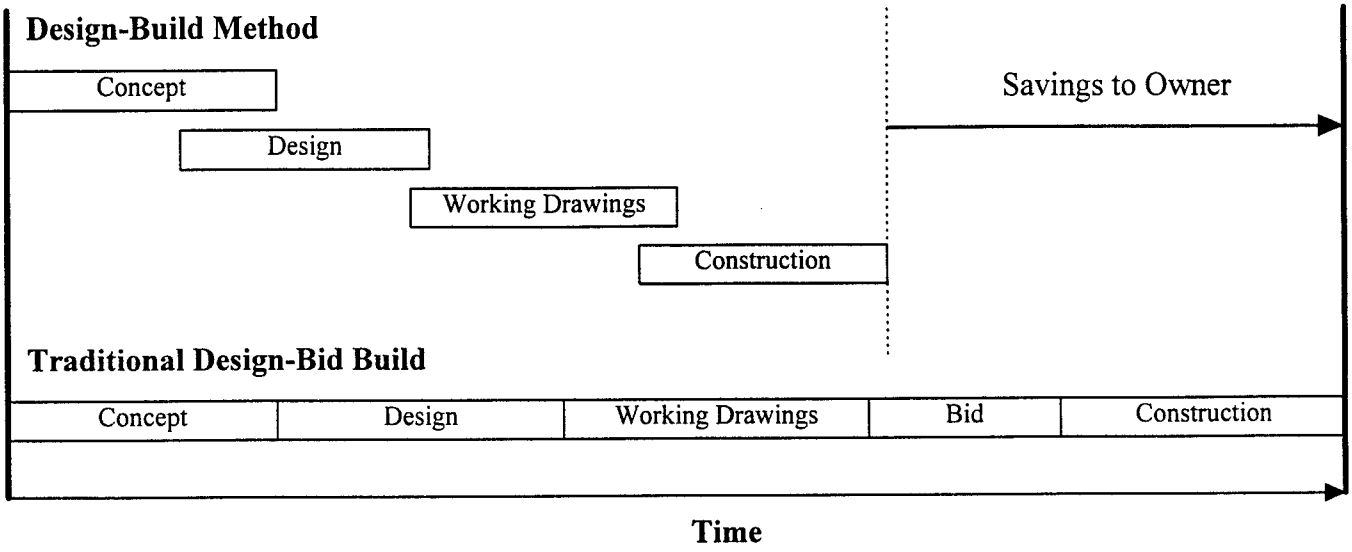
The DB method of contracting was prevalent in this country around the turn of the century. Through the years, however, the process of design was separated from construction. This separation of designer and builder evolved to the current design-bid-build system. There are a number of reasons why this evolution occurred. The principal reason was to produce a viable infrastructure for the least cost to the public. Construction costs are based on competitive bids. The winner is the lowest-bidding responsive and responsible contractor. In the last decade the DB method of contracting has been increasing steadily (Quinn, 1996). The volume of domestic DB contracts has grown from $6 billion to $56 billion since 1982, and now DB contracting represents twenty-three percent of the non-residential U.S. market (Smith, 1996).

The term "turnkey" is often used interchangeably with DB. In many cases the two terms are used for the same type of project contracting. However, there is a difference between the two. The term "turnkey" is used to refer to a special case of DB contracting. In a turnkey contract the constructor performs a complete construction service for the owner. The contractor obtains project financing, procures the land, designs and constructs the project, and turns it over to the owner ready for use (Clough, 1986). Originally the two terms were used for the same type of contracting. In recent years, however, a turnkey contract has separated itself from DB as another alternative contracting method in and of itself.

Design-Build Versus Design-Bid-Build Contracting

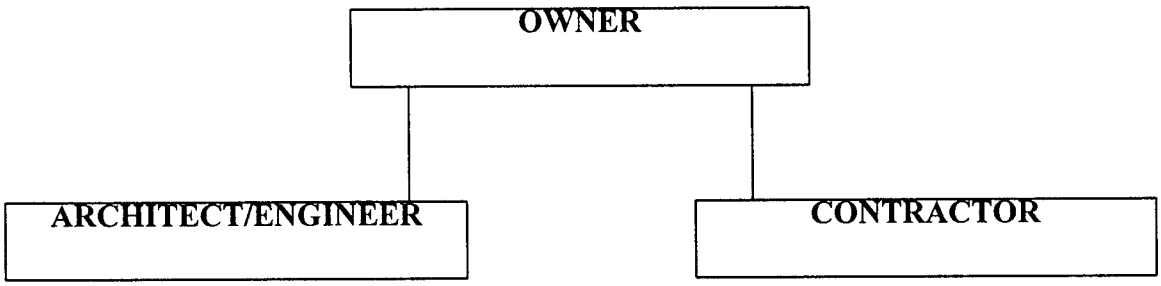
Design-build is a method of contracting in which one entity forges a single contract with the owner to provide both architectural or engineering design services and construction services. Traditionally the method of project delivery has been design-bid-build. In DBB the owner commissions an architect or engineer to prepare drawings and specifications under a design contract, and subsequently selects a construction contractor by competitive bidding to build the facility under a construction contract. Perhaps the greatest advantage that DB has over DBB is the time reduction from beginning of the project to completion.

Figure 1: Design-Build versus Design-Bid-Build Conceptual Time Line.



The DBB method is the one that can be thought of as the "traditional" method of contracting, specifically on public projects. Design-bid-build is also referred to as competitive bidding. In this system the Architect/Engineering (A/E) is selected by the owner first. The selection of an A/E firm can be accomplished three ways: comparative selection, direct selection, or a design competition (Bell, 1996). Once the A/E has been selected and the design has been completed, a notice called an invitation for bid (IFB) is sent out. Contractors interested in the project will respond by submitting a bid. Once the owner has received all bids by the deadline, stated in the IFB, they are opened. The contract is awarded to the lowest responsible bidder. Usually the A/E firm acts as the owner's representative making sure that the project is being built according to the specifications in the contract. A typical organizational format can be seen in figure 2.

Figure 2: Traditional Design-Bid-Build Relationship



Obviously, from its wide spread use throughout the nation DBB is both a viable and efficient method to deliver construction projects. Some of the advantages to DBB are listed below (Barrie, 1992).

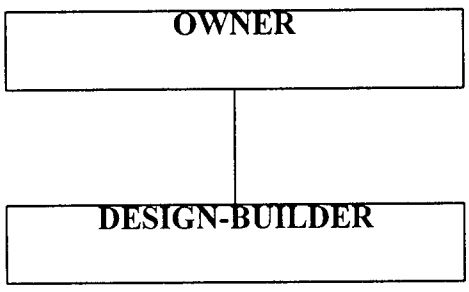
1. Historically accepted and supported with well-established legal and contractual precedents
2. Permits overall cost to be determined before the construction contract is awarded
3. Minimal owner involvement is required in the construction process.
4. Owner may benefit from price competition because of the competitive nature of the bid process.
5. Contractor takes all of the construction risk (except for unforeseen circumstances or impacts).

On the other hand, the philosophical basis for the use of DBB comes from an institutional desire to procure the project at the lowest possible initial cost. Some of the disadvantages are (Barrie, 1992):

1. Overall design-construct time is longest.
2. The owner is often in an adversary contractual position with the general contractor, as is the A/E firm.
3. Changes to the work or unforeseen difficulties will often end in disputes and litigation that can drive up costs in spite of the lowest price concept.
4. The owner has minimal control over the performance of the work.
5. Pressures by the contractor to submit the lowest bid may result in use of marginal subcontractors.

Looking at DB from the same perspective, the differences are apparent. DB combines design and construction responsibilities into one contract and thus one entity. Hence a typical relationship can be seen in figure 3. The DB entity is totally responsible for the completed project. It may be said that integration is the key to DB. Designers and constructors work together to produce a project that meets or exceeds the client's performance criteria. Each member of the DB entity is a team member working to achieve one goal, that of producing a product that will satisfy the client's requirements. Design-Build, by nature, will produce a project with the lowest total cost and reduced time because responsibility is placed on the team (Wesely, 1996).

Figure 3: Design-Build Relationship



Looking at cases from the literature where DB was implemented, there are a number of reasons why DB may be selected over DBB and other types of project delivery methods. Some of the advantages are listed below ("Design-Build: Contracting's Hottest Trend", 1997).

1. Budgets are established and controlled with early cost input
2. Guaranteed construction costs are known early in the project. The decision to proceed with a project is made before considerable design costs are incurred and with a secure knowledge of final cost.
3. Total project time is reduced since design and construction overlap. This time savings results in lower costs and early use of the facility.
4. The owner has single source responsibility. The contractor and A/E work together as a team. This gives the owner an opportunity to focus on the needs and scope definition rather than spending time coordinating between the builder and designer.
5. Quality is higher with single-source responsibility. The owner outlines the terms and the designer-builder furnishes the documents.
6. Change orders are reduced since the designer-builder is responsible for correcting decision errors.
7. Architectural, engineering and contractor fees are determined from the beginning and kept to a minimum.
8. Misunderstandings are minimized. Legal fees are also minimized since most adversarial roles are eliminated.

Despite numerous attractive advantages, implementing DB is not without its potential drawbacks. Some of the disadvantages of DB contracting are listed below (Friedlander and Roberts, 1997).

1. The loss of checks and balances. The designer and constructor are on the same team. This means that the designer is no longer the owner's representative and, as such, does not keep a watchful eye on the constructor.
2. There is less owner control. Since the designer is on the contractor's team, the owner may find limited access to information that it would have been available on a traditional project.
3. DB projects are not easy to competitively bid.
4. There are institutional obstacles. In some areas of the United States, state and municipal laws and regulations severely limit or prohibit the use of design build.

Owner Selection Criteria

Most of the disadvantages of DB contracting can be overcome by carefully establishing a contract that will protect the owner. Institutional obstacles, for public projects, are the most difficult to overcome. As is the case in Texas, these issues must be resolved legislatively. However, these issues are being resolved as the popularity of DB is increases. States are rapidly recognizing the need to change the current laws in order to allow DB contracting.

A study done at the University of Colorado (Songer and Molenaar, 1996) focused on reasons owners, both public and private, prefer DB over DBB in their routine facility procurement process. These reasons in order of their priority are as follows.

1. Shorten duration: The time from concept to project delivery is reduced.
2. Establish cost: A fixed construction cost on a complex project is secured.
3. Reduce cost: Savings due to reduced time and increased constructability accrue.
4. Constructability/Innovation: Several design concepts are compared with direct contractor input.
5. Establish schedule: By lowering the risk of time growth due to design problems found in construction affixed delivery date is secured.
6. Reduce claims: DB's single source of responsibility eliminates design-related claims against the owner.
7. Large project size/complexity: The single source of responsibility eliminates one layer of administration (i.e. owner to designer) and allows the contractor to establish an optimum schedule based on his own constraints rather than being forced to conform to a complex schedule established by the owner.

An after-action report written by the Corridor Design Manager of the Eastern Transportation Corridor Project in Orange County, California (Quinn, 1996) confirms the Colorado findings. This project and ones in the San Joaquin Hills Corridor and Foothill Transportation Corridor totaled approximately $2.5 billion of DB transportation projects to furnish 96 kilometers of new freeways (FWHA, 1996). The analysis by Quinn cites the following benefits for using DB on major highway projects.

- Early lock on total project costs.
- No owner responsibility for design errors.
- Defined areas of risk.
- Guaranteed completion date.
- Shorter overall time frame for project completion.
- Earlier opening of project.
- Less overall funds needed for bond projects.

Finally, Florida, the state with the most transportation DB experience dating back to 1987, sponsored a study on its program. The study looked at thirteen projects worth about $40 million and had the following conclusions (FWHA, 1996).

- Total time for design-build projects was up to 40% less than that required for conventional design-bid-build projects.
- There was no significant change in project costs.
- Claims were essentially eliminated.
- Both State and industry participants indicated a majority supported the concept.

Evaluation Systems

To reconcile DB contracting with government procurement regulations, a public agency must devise a "fair and equitable system" of evaluating offerors' proposals (Procedures, 1990). To do this, an objective methodology for individually comparing each proposal must be developed and its content published in the RFP (Federal, 1994). There have been many solutions to this problem in the past ten years. Some are relatively simple and parallel the existing evaluation systems for A/E design service contracts. Others are very complex (Napier, 1989) and require computer based expert systems and special technical knowledge to understand. One such system was developed by Construction Engineering Research Laboratory and uses fuzzy logic and a myriad of input to identify the optimal condition (Paek, et al, 1992). This type of system is probably justified for use on huge, complex DB projects with a large number of competitors. However, its effectiveness is probably reduced when applied to routine facility procurement. To achieve wide spread acceptance, an evaluation methodology must be simple enough to be understood by both engineers and procurement professionals and flexible enough to be applied to the full gamut of possible project types without the help of outside expertise.

Utility theory is an uncomplicated, flexible means to take a common sense approach to quantifying qualitative data (Riggs and West, 1994) and is employed in various forms by a number of state DOTs as a means to facilitate this computation. DB inherently requires the evaluation of qualitative information (Gransberg, 1995). Such things, as professional competence or past experience are difficult to describe in quantitative terms. To compare these qualities in a manner which is both fair and objective requires the evaluator to rank the qualities of each offeror in the different categories of requested information. This ranking can then be the basis for assigning a relative utility value to each piece of data, and the sum of the relative values in each category for each offeror becomes the quantified value of each proposal when compared to all other proposals.

Other categories of requested information such as price or amount of time to complete the contract are already in quantitative form. Requiring a preliminary highway design cross-section permits the evaluators to quantify expected life cycle costs based on historical data. Thus, the rank ordering of each proposal in these categories takes care of itself. When the relative values of both quantitative and qualitative categories are added up, an overall value can be assigned to each proposal. The proposals can then be compared to one another. To make the methodology more responsive to the owner's concerns and desires, a relative weight can be assigned to each category. The product of the category weight and its relative value becomes the category value, and the sum of the "weighted category values" becomes the overall value for a given proposal.

The evaluation system should consider establishing minimum standards for each category which would disqualify a proposal if not met (Gransberg and Bell, 1996). For example, the RFP would state that the project delivery date shall be no later than a given date. Thus proposals which promise delivery after that date are disqualified. On the other hand, proposals that agree to deliver the project before the deadline would be given a higher relative value than those which

promise delivery on the milestone. Most solicitations required contractors to submit the following categories of information in their DB proposals.

- Technical Excellence
- Management Capability
- Financial Capability
- Personnel Qualifications
- Prior Experience
- Past Performance
- Projected Performance Milestones
- Project Pricing Information

The Utility Theory provides the means to quantify the qualitative. Of the states which responded to requests for information on their DB programs, all used some method which could be classified as an adaptation of utility theory (Arizona, 1997, Colorado, 1997, Florida, 1996, and Pennsylvania, 1994). Through this mechanism, an interdisciplinary team of experts can apply their expertise in a manner which permits the owner to select a DB contractor and get the best value within a system of constraints established by both the quantitative and qualitative needs of the owner. In essence, Utility Theory provides a conduit to bring together two interdisciplinary teams: the owner's evaluation team and the contractor's DB project proposal team. With Utility Theory as their common ground, the DB evaluation team can come together with maximum interdisciplinary cooperation and select a contractor who optimizes the needs of each discipline and produces a successful project.

Florida leads all states in DB contracting of transportation projects. They compiled a comprehensive study of their DB program. Florida recognized the need to revise their statutes in the mid 1980s. With the rapid growth of the DB process during the 1980s Florida legislature began to selectively remove questions of authority of particular public agencies to use the DB concept. In 1986, the legislature provided statutory authority for both "turn key bidding" and "design/build bidding" for the construction of schools (Fla. Stat. § 235.211). Also, a statute (Fla. Stat. § 337.11(5)(a)) was added by the Florida legislature effective July 1, 1987 that expressly permits combined design and construction contracts for FDOT work. In 1989 the Florida legislature further expanded the scope of their laws regarding DB by expanding the scope of the Consultants Competitive Negotiation Act (CCNA) exemption to cover DB contracts involving any public agency in the State of Florida (Department of Civil Engineering College of Engineering University of Florida, 1991).

Task 2, Legal Review

Legal issues are of great concern when it comes to DB contracts. Many states have specific laws regarding the DB method of contracting for public works projects. Many states, including Texas, have prohibited the use of DB for public projects. According to the Design-Build Institute of America (DBIA) Florida, California, Massachusetts, New York, New Hampshire, Virginia,

Idaho and Washington specifically authorize and/or encourage the use of DB contracting methods.

A comprehensive review of State law regarding the use of DB as a legal mechanism to procure public projects was made by the TxDOT General Counsel's Office to identify any restrictions on the legal use of this procurement method for TxDOT projects. The assistance of the Texas Society of Professional Engineers and the State Board of Registration for Professional Engineers was sought to expedite this search. All actual and possible restrictions and constraints were cataloged and recommendations for legislative changes were made to permit TxDOT to maximize the benefits of using this innovative contracting method to deliver public projects for Texas. TxDOT Attorney Joanne Wright produced an analysis of the status of the law with regard to DB contracting on public highway projects.

She found that it was not possible to implement DB for TxDOT highway construction projects without a change in legislation. The conclusion of her brief is best summarized by the following quotation.

"Section 223.001 of the Transportation Code states, "The department shall submit for competitive bids each contract for the improvement of a highway that is part of the state highway system." Attorney General Opinion JM-282 (1984) outlines the distinction between contracts for construction and contracts for the planning of construction, holding that the former does not include the latter. Section 233.001, then, applies only to the actual construction of the highway. Pre-construction contracts require the services of professionals or consultants and are governed by the Professional Services Procurement Act, Chapter 2254 of the Government Code. See Op. Tex. Att'y Gen. No. JM-940 (1988)."

"The provisions of the Engineering Practice Act, article 3271a, V.T.C.S., require that design work on a construction project be performed by a registered professional engineer. Section 19 of the Act prohibits the State from constructing a public work unless the plans and specifications and estimates have been prepared by a professional engineer and the engineering construction is executed under the direct supervision of a professional engineer. State agency procurement of engineering services is governed by '2254.003 of the Government Code, which requires that such contracts be awarded "on basis of demonstrated competence and qualifications" of the provider. In the same statute, the legislature goes a step farther than simply exempting professional services from the competitive bid requirement: "A government entity may not select a provider of professional services . . . or award a contract for the services on the basis of competitive bids." Any contract made, whether directly or indirectly, in violation of this statute is void as against public policy ('2254.005, Government Code). See also, *State v. Steck,* 236 S.W. 2d 836 (Tex. Civ. App.--Austin 1951, writ ref'd)."

Thus, the Engineering Practice Act is in conflict with the Transportation Code, and in order to implement DB in future highway construction projects legislation which reconciles the difference must first be enacted.

In reviewing the DB procedures for other states, a possible exception to the restriction was found. A number of states including Florida, Arizona, and North Carolina use an abbreviated DB procedure called Low Bid Design-Build (LBDB). In this procedure contractors are pre-qualified using procedures similar to the qualifications-based selection of design contractors, and then sealed bids from those contractors which meet the qualifications criteria are opened. The contract is awarded to the lowest, pre-qualified contractor. A cursory review of this procedure by Wright revealed no specific prohibition to the use of such a procedure in Texas. However, a detailed review would be required before it could be formally implemented. In any case, the use of LBDB reduces the potential benefit from a best value selection of a DB contractor by not considering the relationship between the quality of the technical proposal and the quantity of the price. Nevertheless, the use of LBDB warrants further consideration, and as a result it is included as one of the three viable DB alternative methodologies. It is discussed in detail in the Best Practices section of this report.

Task 3, Evaluation Of Current TxDOT Procedures In Pavement Design And Contracts

In this task, a complete evaluation of the current TxDOT procedures pertaining to pavement design, construction, and contracting was conducted. Possible future developments in these areas as identified in ongoing research projects and the TxDOT Long-Range Research Plan were also researched. The researchers analyzed pavement design and evaluated computer programs such as FPS-19. The researchers obtained additional information through interviews with TxDOT personnel in the Abilene district who are involved in the design and construction phases of pavement related projects.

Pavement Design

TxDOT currently follows the traditional DBB approach for their pavement construction activities. TxDOT engineers use computer-based methods to design both pavement construction and rehabilitation projects. These designs, together with TxDOT materials specifications, serve as the technical basis for Requests for Proposal (RFP). In a DB contract scenario, the contract will generally include all aspects of a construction project including design, construction, and quality control. However, depending on the characteristics of the industry and the needs of the funding agency, variations do exist in the way DB contracts are stipulated (Ellis, et al, 1991). The following list is bid evaluation methods adopted by Florida DOT.

1. Thirty-five to fifty percent of the bid accounts for technical criteria including constructability, future expansion, maintenance of traffic flow, safety, environmental impacts, innovation of design/construction, application of sound design criteria, and understanding of the scope of services.
2. Thirty to forty-five percent explains management criteria including aspects such as contractor's experience, adverse effects of construction on public, achievement of special level of quality, experience of the firm with DB, location of firm, previous joint contractor-consultant experience, and the experience of the design team.

3. twenty percent describes the project schedule including contractor's and consultant's schedules and the ability to meet the schedules.

Deen (1990) identified the following design-related features unique to the DB contracting practices of some states.

1. In Kentucky, all designs are the responsibility of the contractor.
2. In Georgia and West Virginia, the contractor's designs are allowed as alternates to the contract plans furnished by the state highway agencies.

The following issues should be considered in implementing a DB for new pavement construction or rehabilitation projects.

1. Design responsibility (either sole responsibility or alternative choices)
2. Level of design detail required at the time of evaluating proposals
3. A procedure and a basis to evaluate the contractor's design
4. The need to evaluate a proposal based on the total life-cycle cost for the project
5. Traffic control plan during construction
6. Specifications for materials to be used in the project (TxDOT 1993)
7. Quality control/quality assurance issues (TxDOT 1993)
8. Acceptance criteria (based on method, performance-based or end-result specifications)

TxDOT Pavement Design Systems

TxDOT pavement design procedures include design systems for both flexible and rigid pavements. TxDOT engineers design flexible pavements using the computer-based Flexible Pavement System (FPS). The rigid pavements are designed using the AASHTO method. This research project is limited to flexible pavements and therefore, this section discusses only the FPS.

In January 1995, TxDOT implemented new technical analysis criteria for its FPS. The new FPS, labeled FPS-19, continued to be based on the pavement serviceability concept similar to the AASHTO design system (Scrivner and Michalak 1969). However, FPS-19 included the following changes from its predecessor, FPS-11.

1. Use of pavement deflections obtained from the Falling Weight Deflectometer (FWD) instead of the DYNAFLECT
2. Pavement layer backcalculation using the MODULUS backcalculation program instead of the STIFF2 computer program
3. Use of pavement layer moduli instead of layer stiffness coefficients

FPS-19 is recommended for the design of flexible pavements with flexible bases, asphalt stabilized bases and lightly stabilized (less than 3 percent stabilizing agent) bases. It is also recommended for the design of overlays. However, FPS-19 is not recommended for pavements

with layers comprising of Portland cement concrete or heavily stabilized materials or for overlays on cement treated or concrete bases.

FPS-19 can be used for new pavement design, overlay design for existing flexible pavements, and for pavement rehabilitation design. The following list is a summary of best design strategies for the design system.

1. Layer configuration (layer materials and thickness)
2. Initial construction cost
3. Overlay construction cost
4. Routine maintenance cost
5. Total life-cycle cost

Design of New Flexible Pavements Using FPS-19

If the project is a new design or a rehabilitation design, the designer has to provide data for the design system. Data required for a new design include the following.

1. Values for depth to bedrock and subgrade modulus- These values are obtained from backcalculating adjacent pavements
2. District generated moduli values for layer materials
3. Traffic (current ADT, future ADT, and cumulative 18-kip estimates)
4. Length of analysis period (pavement design life)
5. Confidence level for design data - There are existing TxDOT guidelines to select a confidence level for design data based on the type of highway and its importance.

Design steps for new pavement design using FPS-19 are listed below.

1. Test adjacent highway section with falling weight deflectometer (FWD) to obtain Depth to Bedrock and Subgrade Modulus, or use default values available in the district.
2. Use district generated layer moduli values for base and surface, or use default values
3. Input traffic data, pavement design life and confidence levels for data in FPS-19

Design of Flexible Pavement Overlay Design Using FPS-19

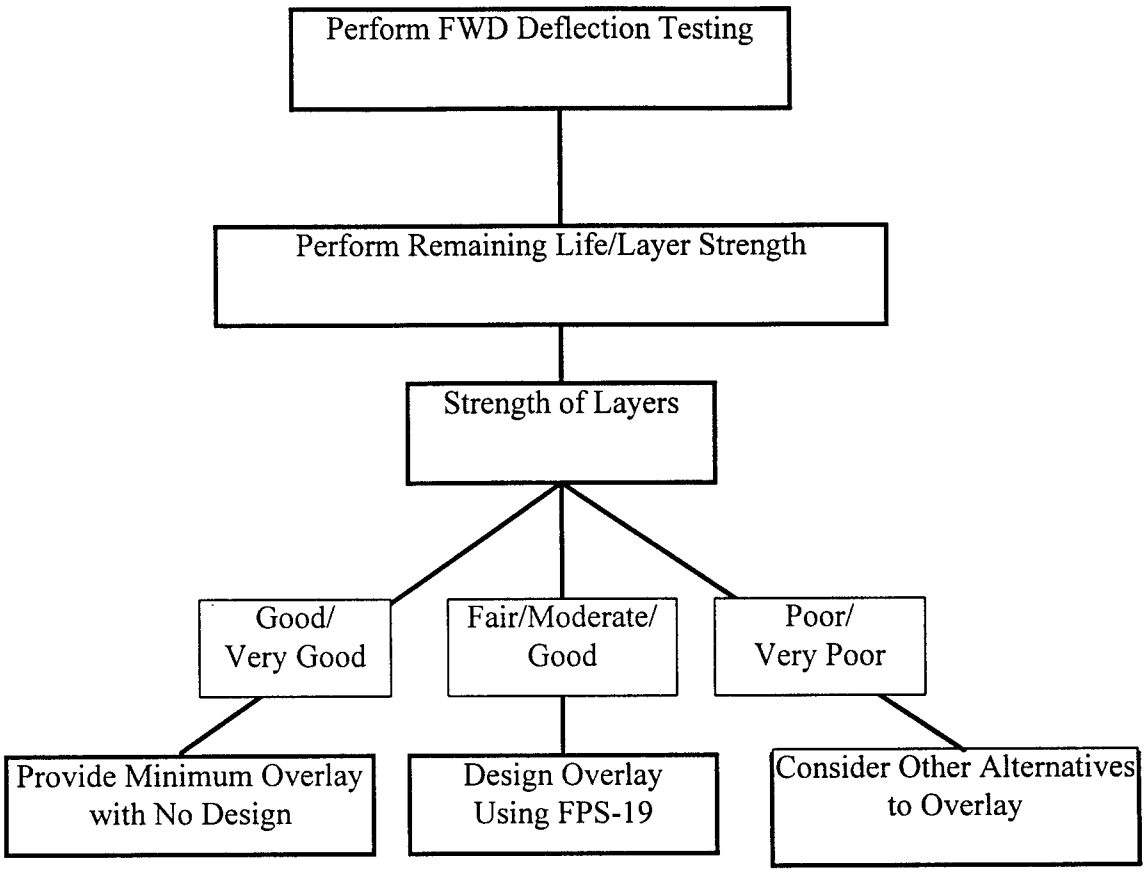
Design steps for a flexible pavement overlay design are listed below.

1. Test existing pavement section with FWD.
2. Run MODULUS computer program on FWD data to perform remaining life analysis and layer strength classification:
    - -If strength is good or very good, no design is needed. Use minimum overlay thickness.
    - -If strength is fair, moderate, or good, use FPS-19 for the design of overlay.
    - -If strength is poor or very poor, consider other alternatives to overlay.

Design of Flexible Pavement Rehabilitation Design Using FPS-19

For a pavement rehabilitation design, the design procedure is different from a new design because of the necessity to evaluate the existing pavement structure. This evaluation is referred to as a remaining life analysis, and it is based on deflection testing using the FWD. Based on this evaluation, rehabilitation strategies are recommended. Fig. 4 illustrates the current TxDOT approach on pavement rehabilitation design, and Table 1 outlines the data requirements for pavement design at various stages of the process. One of the key aspects of pavement rehabilitation design for DB contracts is sharing the pavement monitoring information collected by TxDOT with the prospective DB contractors.

Figure 4: Schematic Diagram of TxDOT Pavement Rehabilitation Design Process.



In considering additional alternatives to overlay, the following steps are taken.

1. Obtain data on performance history.
2. Run additional tests as needed (coring, ground penetration data) to identify causes of the problem.
3. Generate a design to fix the problem.
4. Evaluate design alternatives.

Table 1: Data Requirements for Pavement Rehabilitation Design

Design Segment	Data Description
MODULUS backcalculation	Existing layer material types
	Existing layer thicknesses
	FWD deflection data
MODULUS remaining life analysis	Cumulative 20-year, 18-kip ESAL
	Percent alligator cracking
	Average rut depth
Design program (FPS-19)	Current and Future ADT
	Cumulative 20-year, 18-kip ESAL
	Beginning and ending PSI
Design strategy selection	Construction/maintenance history
	Type and date of last resurfacing
	Data from forensic studies
	Area engineer's recommendation for rehabilitation
	District recommendation for rehabilitation

Current TxDOT Contract Procedure

The general guidelines for TxDOT contracts, which are based on the traditional DBB method, are stipulated in the TxDOT Standard Specification for Construction of Highways, Streets, and Bridges (1993). Some of the pertinent features of the current procedure are outlined below.

Bidding Process

When a construction project is up for bid, upon written request from the bidder, the following information will be furnished through a proposal form.

1. The location and description of the proposed work
2. An approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished
3. A schedule of items for requested unit prices
4. Time which work is to be completed

The prospective bidders are also provided with a set of plans and standard TxDOT specifications. Special provisions and specifications to the project that are not included in the TxDOT standard specifications will be attached to the proposal form. This proposal form will not be provided unless the bidder files with TxDOT at least 15 days prior to the bid submission date, an acceptable annual statement of financial resources and experience on similar work.

The signed contract will include, but not limited to, the plans, Standard Specifications incorporated by reference, special provisions, special specifications, contract bonds and

supplemental agreements. Therefore, before submitting a bid the bidder should examine the proposal, plans, specifications, special provisions and the form of the contract to be entered into for the work to be completed.

At the time of submission, a proposal guaranty should accompany the proposal which is security furnished by the bidder as a guaranty that the bidder will enter into a contract if awarded the project. TxDOT may retain this proposal guaranty until after the contract has been awarded.

The proposals are opened publicly and read. All of the bids are compared and the results are made available to the public. The contract is awarded to the lowest bidder. Within 15 days after written notification of award of the contract, the bidder shall execute and furnish to the State Transportation Commission, the contract, together with a performance bond and a payment bond. Each should be in the full amount of the contract price. The certificate of insurance must show coverages in accordance with contract requirements.

Scope of Work

The Engineer reserves the right to make, in writing, at any time during the work, changes in quantities and alterations in the work that are necessary to satisfactorily complete the project. If such alterations or changes in quantities significantly change the character of the work under contract, than an adjustment, excluding profits, will be made to the contract. The basis of such adjustments shall be agreed upon prior to the performance of the work. If the alterations do not significantly change the character of the work to be performed, the altered work will be paid for as provided elsewhere in the contract. A "significant change" shall be construed if the following occurs.

1. When the character of work, as altered, differs materially in kind or nature from that involved or included in the original proposed construction
2. When a major item of work is changed by more than twenty-five percent of the original contract quantity. A major item is any individual bid item included in the proposal that has a total cost equal to or greater than five percent of the original contract or $ 100,000, whichever is less.

Work made necessary by changes and alteration of the plans or for other reasons for which no prices are provided in the contract shall be defined as "Extra Work". Before any extra work is begun, a "Supplemental Agreement" is executed, or a written order is issued by the Engineer to do the work on a "Force Account" basis.

Control of the Work

The plans made available at the time of bid show, in detail, the work to be accomplished under the contract. When working drawings are required, they will be treated as indicated in Table 2.

TABLE 2. Requirement for Working Drawings in TxDOT Construction Projects (Ref)

No.	Working Drawings for	Require Registered P.E.'s Signing, Sealing and Dating ?	Requires Departmental Approval ?
1	Alternate or optional designs submitted by contractor	Yes	Yes
2	Supplementary fabrication and shop drawings for structural items	No, unless required on the plans	See applicable item
3	Contractor proposed temporary facilities, that affect the public safety, not included in the plans	Yes	Yes
4	Form details for (a) Bridges, ret. walls & other major structures (b) Minor structures	Yes, unless otherwise shown on the plans No, unless otherwise shown in plans	Yes No, unless otherwise shown in plans
5	Erection drawings	Yes	Yes
6	Contractor proposed major modifications to the traffic control plan	Yes	Yes

The work done by the contractor is checked by an inspector who is appointed by the Engineer. In case of a dispute arising between the contractor and the inspector with regard to materials supplied or the work performed, the inspector has the authority to reject materials or suspend work on the operation until the engineer resolves the question. When the United States Federal Government is to pay a portion of the cost of the work covered by the contract, the work is subject to inspection by U.S. government representatives.

Once the work on the project is complete, a final inspection is made within ten days of such notification by the contractor. If the final inspection results in a final acceptance, then the contractor is not released from responsibility for all items, materials or equipment requiring performance test periods or final measurements unless otherwise shown in the contract.

Control of Materials

Before they are incorporated in the work all materials shall be inspected, tested, and approved by the Engineer. The engineer will sample and test all of the materials to be used based on standard tests specified by TxDOT. In certain cases, subject to conditions established in a written agreement between a supplier and the Director of Materials and Tests, pre-tested and approved

materials may be used. An example for this is the Rated Source Polish Value (RSPV) catalog maintained by the Materials and Tests Division for aggregates to be used for pavement surface courses.

Legal Relations and Responsibility to the Public

The contractor has the responsibility to provide for traffic along and across the highway, as well as for ingress and egress to adjacent property. This is in accordance with the traffic control plan and detours as shown on the plans and in the specifications for the project. During construction, unless otherwise shown in plans, the Contractor is responsible for the construction and maintenance of detours and temporary structures as designed or directed by the Engineer. The contractor has the sole responsibility for providing, installing, moving, replacing, maintaining, cleaning, and removing upon completion of work all barricades, warning signs, barriers, cones, lights signals, and other such types of devices. The contractor is also responsible for handling traffic as shown on the plans. These devices shall conform to TMUTCD.

Prosecution and Progress

The contractor is not permitted to assign, sell, transfer, or otherwise dispose of the contract or any portion thereof, or his rights title, or interest therein without the approval of the Texas Transportation Commission. The contractor also needs to obtain approval from the Engineer to sublet any portion of the contract.

Unless otherwise mentioned in the plans, the contractor has to submit a bar chart outlining the schedule of planned major work activities to the Engineer for approval. This bar chart needs to be updated and any revisions need to be approved by the Engineer. If a critical path method is specified on the plans in lieu of a bar chart, such schedule has to use the Arrow Diagram Method or the Precedence Diagram Method. Time charges will be considered to begin fifteen calendar days after the date of the written authorization by the Engineer to begin work. If the Contractor fails to complete the contract during the period specified, a time charge will be made for each working day thereafter.

Measurement and Payment

Payment is made once each month for the work executed and the materials brought in for construction and stored at site. Upon acceptance, the remaining amount will be paid. In order for TxDOT to accept the completed construction project, the following conditions must be met.

1. The construction operation was completed to the satisfaction of the Engineer.
2. The materials used in the construction were of a quality acceptable to the Engineer.
3. The completed structure is in a condition that is acceptable to the Engineer at the time of acceptance.
4. The contractor has satisfied all the conditions stipulated in the contract.

Task 4, Best Practice Survey

Surveys were developed and sent to all State DOTs and Federal agencies including the Federal Highway Administration and the Corps of Engineers, who routinely procure design and construction services using DB, to identify the "best practice" in use throughout the nation. A preliminary survey, which only asked for the name of a point of contact who handles DB and whether or not each state had experience with DB, was sent. This permitted the research team to focus on those DOTs which had actual DB experience. Based on the response from the initial survey, a second, detailed survey was prepared and sent directly to the designated state point of contact. This survey was customized for each group and focused on identifying policies, procedures, and contract language which has been successfully used on the types of projects TxDOT will attempt in the future. Specific emphasis was placed on gaining knowledge on the evaluation of pavement design proposals, construction costs, and the quantifying of life cycle costs based on statistical performance data. Additionally, a copy of a nationwide survey on DB conducted by the Design-Build Institute of America (DBIA) was obtained (DBIA, 1996). This study helps put the results of the survey of DOTs in perspective. Before the details of our surveys are presented, it will be helpful to discuss the DBIA survey and allow it to establish the national context in which we must analyze the data obtained.

In 1996, DBIA surveyed the Offices of the Attorneys General of all fifty states and the District of Columbia. The overall purpose of the study was to "benchmark the acceptance and use of alternative and innovative contracting methods permitted by state governments" (DBIA, 1996). There were twenty-seven states which reported that DB was a permissible procurement mechanism. Only nine states had laws which expressly forbade DB. Interestingly, Texas was not among those nine. Of the states which did not permit DB, four reported that it was possible to use a DB subcontractor. Texas was in this category. Forty-five states reported that they are required to select A/E services on a qualifications-bases process, and forty-eight states stated that they were required to award construction contracts which do not include design by competitive bids. Finally, twenty-nine states reported that they employ contracting methods other than DBB to procure projects. Texas was not among that group. It is also interesting to note that the information reported by the Texas Attorney General's Office appears to conflict with that found by the TxDOT General Counsel's Office. We attribute this discrepancy to a less than accurate response by the Attorney General's Office. Additionally, the TxDOT response was a documented brief rather than a questionnaire response; therefore, the writer was directly focused on the specific application of DB in the Department rather than a broad, all-encompassing Yes/No response to the use of DB throughout the state in both private and public projects.

When this information is taken along with information collected by the FHWA, an interesting picture emerges. Only fifteen out of fifty state DOTs are currently using DB to procure highway and highway related projects, and the FWHA has approved DB projects in the following thirteen states: Alaska, Arizona, California, Colorado, Florida, Maine, Michigan, Minnesota, New Jersey, North Carolina, Ohio, South Carolina, and Utah (FHWA, 1996). The geographic dispersion of the states who have adopted DB almost covers the entire country. No specific region seems to either accept or reject DB. The experience of the Federal government is also cogent to this

discussion. The Department of the Navy reported a 15% savings in DB project cost and a 12% reduction in facility delivery time over DBB projects. The Department of Defense Nonappropriated Fund projects showed savings of 18% in costs and 14% in time (DBIA, 1996). Obviously, some state DOTs are seeking to accrue benefits similar to those realized by federal engineering agencies.

Best Practices in DOT Design-Build Contracting

Reviewing the practices used by other DOTs to award DB contracts, three basic methods seem to be used uniformly around the nation. Each state has its own variations on the same themes, but it can be determined that these three methods constitute best practices because they are used in more than one entity and are generically standardized at both state and federal levels. The three alternatives are (Arizona, 1996; Colorado, 1996; Florida, 1997; Pennsylvania, 1995; USACE, 1994, FAR, 1997):

- Low Bid Design-Build (LBDB): the DB contract award is based on the lowest responsive bid where the offeror meets also professional qualification requirements.
- Adjusted Score Design-Build (ASDB): the DB contract award is based on the lowest adjusted score, which is determined by dividing the price proposal by the technical proposal score.
- Best Value Design-Build (BVDB): the DB contract is awarded on the basis of an objective determination of best value where the contract price is a portion of the decision criteria but not necessarily the primary factor.

One of these alternatives, depending on the project type, is used to select the contractor to perform design-build services. The LBDB approach should be used on projects where the scope is very tight and clearly defined and innovation or alternatives are not being sought. This might include bridge projects with a specified foundation type, span lengths, and beam type.

The ASDB approach works well when overall outcomes can be clearly defined, and a number of alternatives may exist which could provide the outcomes desired. This could include bridge projects where alternative foundations, spans, and material types are acceptable.

Finally, the BVDB method should be selected when innovation and new technology as well as the requirement for specific types of experience is required to obtain the desired outcome. This approach should also be used when a fast track schedule is required or when external factors such as traffic disruption or innovative environmental protection is inherent to the successful execution of the project.

Another item which qualifies as a Best Practice involves the process of prequalification of all proposers regardless of the type of award process used. This practice is prudent with respect to federal requirements of the Brooks Act and the Texas Engineering Practices Act. The prequalification process can be designed to fulfill both Federal and State requirements for qualification based selection of design services. It also helps remove opposition from the design community with regard to competitively negotiated procurements such as BVDB. Generally, the

DB contractors are prequalified by submitting the following categories of information in their proposals (Ellicott, 1994).

- Management Capability
- Financial Capability
- Personnel Qualifications
- Prior Experience
- Past Performance

Sometimes, the DB contractors are asked to furnish a technical approach to the design as well as the other items of information to ensure that the designer of record is properly qualified to perform the type of design. The Republic of Turkey uses a very simple and yet strict prequalification system which requires minimal effort to prepare, but it effectively eliminates any contractor without the required qualifications and experience. (Resmi Gazette, 1996) The Turkish system assigns 100 points for a perfectly qualified contractor. They then break the required qualifications down into the necessary categories and assign a minimum and maximum number of points that a contractor can win by submitting evidence of qualification. The categories are highly objective and fall into the following areas.

- Past experience quantified by a measurable standard- For example, a highway project would require a minimum number of kilometers of completed highway of a certain standard.
- Personnel qualifications in terms of professional registration (or another internationally recognized qualification) and years of experience
- Financial capacity as measured by the maximum size bank letter of guarantee (an international version of the performance bond) which could be tendered at the time of the award
- Experience performing similar projects in other countries as evidenced by certificates provided by the owners of completed projects

The Turks enforce the prequalification procedure rigorously to the point of canceling solicitations if no qualified contractors submit letters of interest and prequalification. Thus, prequalification is an extremely important facet of successful DB contracting and must be given as much thought as the preparation of the RFP.

The final element of Best Practice deals with the announcement of DB projects. Several states and the Republic of Turkey request a preliminary letter of interest (LOI). This allows interested DB contractors to indicate their willingness to consider submitting a proposal and receive limited feedback regarding their potential without the expense and time associated with developing and submitting a full scale proposal. The LOI allows the potential proposer to briefly outline their qualifications and receive an appraisal of how their qualifications compare to the criteria. The State of Florida (Florida, 1996) has a standard announcement requesting LOIs and procedure for processing and responding to LOIs. Florida only uses LOIs as a prelude to ASDB contracts and reserves LOIs for projects which have some degree of technical complexity or the requirement for the use of innovative technology. Florida is satisfied with the program and has included it in their procurement regulations (Xanders, 1997).

Two documents were developed from a synthesis of the best DB practices. The first is the Design-Build Specification made up of the deliverables under this contract. The second document is a set of recommended guidelines for Design-Build procurement and administration which has been published under separate cover. Both documents are intended to provide the foundation from which TxDOT can implement a DB program if and when the enabling legislation is enacted.

Task 5, Identification of Design Aspects and Acceptance Criteria Relating to the DB Contract Procedure

During this task, the researchers identified the following information relating to the DB contract procedure. The identification of these factors helped in the development of the DB Evaluation Model in Task 6. In design-build contracting, important decisions need to be made on the following issues.

1. Level of detail needed for the design submitted with the contractor's bid proposal
2. Evaluation method for contractor's design
3. Material quality and quality control/quality assurance procedures
4. Acceptance criteria for the completed pavement

Literature survey evaluation of current TxDOT procedures and the best practice survey indicated that TxDOT pavement rehabilitation projects appear to be suitable to implement DB contracts. This will enable TxDOT to announce Request for Proposals (RFP) for pavement rehabilitation projects even prior to performing detailed investigations to identify problems associated with the existing pavement structure. The following data will be available for the contractor in case of a pavement overlay or rehabilitation project.

1. Current and future ADT
2. Information on the existing pavement structure (layer materials, aggregates, thicknesses, etc.)
3. Results from the most recent FWD tests conducted on the existing pavement
4. Any other information already available from the TxDOT Pavement Management Information System (PMIS)
5. TxDOT standard specifications, general provisions, special specifications, and special provisions for materials and construction

The information given above, may be used in conjunction with the following information.

1. Design life (or analysis period)
2. Reliability of the design (or confidence level for design data)
3. Traffic control plan
4. Construction time
5. Candidate rehabilitation options

The contractor can select the design life and the reliability level for the design. The contractor's traffic control plan and the scheduled construction time will be weighed into the technical

evaluation criteria in the proposal. The design method used by the contractor shall have the capability to use the design data indicated above, and the contractor is expected to provide, along with the design, a life-cycle cost for the pavement for the design life considered along with the costs of initial construction, routine maintenance, and overlay/seal coat operations where applicable. The contractor should be strongly encouraged to consider the user cost for the pavement rehabilitation project. In the technical evaluation, the traffic control plan and the construction time will be evaluated with the TxDOT assessment of cost for the road user. This user cost can be calculated using the FPS-19 pavement design program currently being used by TxDOT. The user cost feature in the FPS-19 was instituted as a result of a FHWA mandate and it is not being used to any significant extent at this time. This will be one application where TxDOT can put this feature in the design computer program to good use. The following design methods for flexible pavements were investigated in this study for their suitability in design-build contracting.

1. Current TxDOT design method (FPS-19)
2. Previous TxDOT design method (FPS-11)
3. AASHTO design method
4. The Asphalt Institute design method
5. US Army Corps of Engineers' Flexible Pavement Rehabilitation design method (PAVER)

The two design methods developed by TxDOT (FPS-11 and FPS-19) provide candidate designs together with pavement life cycle costs for review and selection by the designer. These two design systems also calculate the road user cost. Rut depth and fatigue cracking are the two failure criteria considered in these design methods. They also allow for the input of a confidence level for pavement design input data.

The AASHTO design method provides one optimum design that would satisfy the design criteria. The calculation of life cycle costs is not included in the design procedure, but it can be done separately. The variability in design input data is handled through a reliability number and a standard deviation. The Asphalt Institute Method does not allow the designer to identify reliability. A separate computer program is available from the Asphalt Institute to conduct life cycle cost analysis.

The PAVER design method of the U.S. Army Corps of Engineers is a comprehensive pavement maintenance management system that incorporates all of the features identified with other design systems above. Figure 5 provides a comparison of four designs done using the first four design methods identified above. An effort was made to use the same input data as much as possible.

The design method used by the DB contractor may include either of the above methods. However, the contractor should be encouraged to use a design method that will easily provide life cycle costs for different design alternatives. The design method should also consider some form of failure criteria for the design. The failure criteria may include a combination of rutting, fatigue cracking, or a damage based model.

DESIGN OPTION-1 AASHTO METHOD	DESIGN OPTION-2 ASPHALT INSTITUTE METHOD	DESIGN OPTION-3 FPS-19 METHOD	DESIGN OPTION-4 FPS-11 METHOD
4" HMAC (Type D Surf.) γ= 140 pcf; Cost/CY= $60.48	5" HMAC (Type D Surf.) γ = 140 pcf; Cost/CY = $60.48	4" HMAC (Type D Surf) γ = 140 pcf; Cost/CY = $ 60.48	4" HMAC(Type D Surf) γ = 140 pcf; Cost/CY = $60.48
7" Type A or B ASPH.STABILIZED BASE γ = 133pcf; Cost/CY = $53.86	10.5" Type A or B ASPH. STABILIZED BASE γ = 133 pcf; Cost/CY = $53.86	4" Type A or B ASPH.STABILIZED BASE γ = 133 pcf; Cost/CY = $53.86	7.5" Type A or B ASPH.STABILIZED BASE γ = 133 pcf; Cost/CY= $53.86
10.5"FLEXIBLE BASE (Ty. A Gr. 4 Cl. 4) γ = 95 pcf; Cost/CY = $21	6"FLEXIBLE BASE (Ty. A Gr. 4 Cl. 4) γ = 95 pcf; Cost/CY = $21	12.5"FLEXIBLE BASE (Ty. A Gr. 4 Cl. 4) γ = 95 pcf; Cost/CY = $21 Life of initial structure = 40 yrs.	4"FLEXIBLE BASE (Ty. A Gr. 4 Cl.4) γ = 95 pcf; Cost/CY = $21 Life of initial structure= 14 yrs With 2" overlay after 14 yrs & 1.5" overlay after 23 years

Input Data

(1) Reliability- 95%
(2) Analysis Period = 30 yrs.
(3) ADT (Current)- 10000/day
(4) 20 years ESAL- $15.91 * 10^6$
(5) Elastic moduli of materials: $E_{AC} = 400$ ksi $E_{TS} = 300$ ksi $E_{SB} = 20$ ksi $E_{SG} = 8$ ksi
(6) Serviceability index of initial structure (P_o) = 4.5
(7) Minimum Serviceability index (P_t) = 2.5

FIGURE 5. Comparison of Designs from Four Design Methods

Material Quality

The best option with regard to material quality is to allow the contractor to use sanctioned TxDOT standard procedures to evaluate the material quality. However, the contractor should be encouraged to propose alternative test methods. If the proposed methods are not acceptable to TxDOT, the Technical Review Committee may ask the selected contractor to revert to the standard TxDOT procedure applicable to that particular material property.

Construction quality can be monitored using the TxDOT procedures available at the time the RFP is announced. In cases where TxDOT QC/QA specifications are available, such as for hot mix asphalt concrete, the contractor could be made responsible for the QC/QA activity. However, it should be stipulated that such tests need to be supervised by a registered professional engineer. TxDOT may perform a few verification tests for each construction operation depending on the nature of the application and the quantity of the material used.

Acceptance Criteria

The acceptance criteria for a pavement construction or a rehabilitation project would be identified in current TxDOT standard procedures except where additional criteria is stipulated under special specifications. An example for special specifications for pavements is Special Specification 5000: Ride Quality for Pavement Surfaces.

Task 6, Develop DB Evaluation Model

This task involved applying Utility Theory to the problem of evaluating DB proposals and providing an objective means to award a DB contract based on some form of lowest and best bid basis. In essence, the task has three components. First, a list of evaluation factors and performance criteria must be made. This list should include, as a minimum, the items listed below.

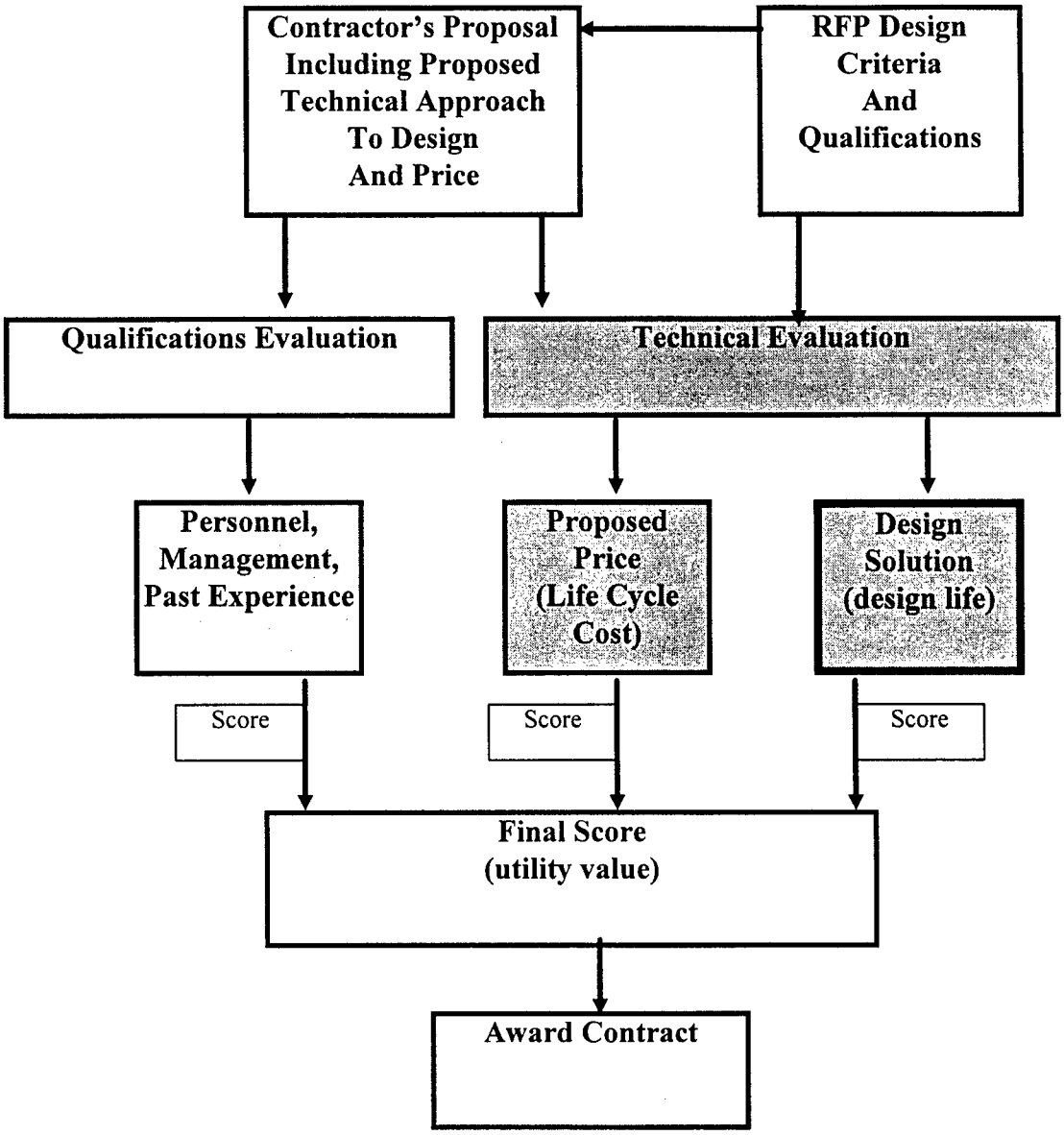
- Construction cost
- Construction period
- Design approach
- Proposed design life cycle cost
- Design comparison to FPS-19 standard
- Contractor experience
- Contractor management plan
- Contractor traffic control plan
- User costs of construction

Next, we developed an algorithm to assign a Utility Value and weight to each evaluation factor. The algorithm will permit TxDOT management personnel to compare each proposal to a predetermined standard which can be published in the RFP. Each proposal can be ranked in order on technical value and life cycle cost basis. Thus, the contract award group can then do a cost-technical value trade-off to make an award on the lowest and best bid basis. This algorithm

will become a DB Evaluation Model and take the form of a computer spreadsheet which can easily be manipulated with minimal training. Figure 6 is a flow chart which describes the process in a generic form.

The model includes the three alternative selection procedures identified in the Best Practices review: Low Bid Design-Build (LBDB), Adjusted Score Design-Build (ASDB), and Best Value Design-Build (BVDB). Each alternative has its own application and methodology. It must be noted that the hallmark of successful implementation of DB programs is the preservation of flexibility within the procedures administered in the program. Each project will present its own unique set of challenges, and only with a flexible model will the engineer be able to develop an evaluation plan which can be adapted and individualized on a project by project basis. All three methods use the services of Technical Review Committee (TRC) to evaluate contractor proposals and recommend contract award.

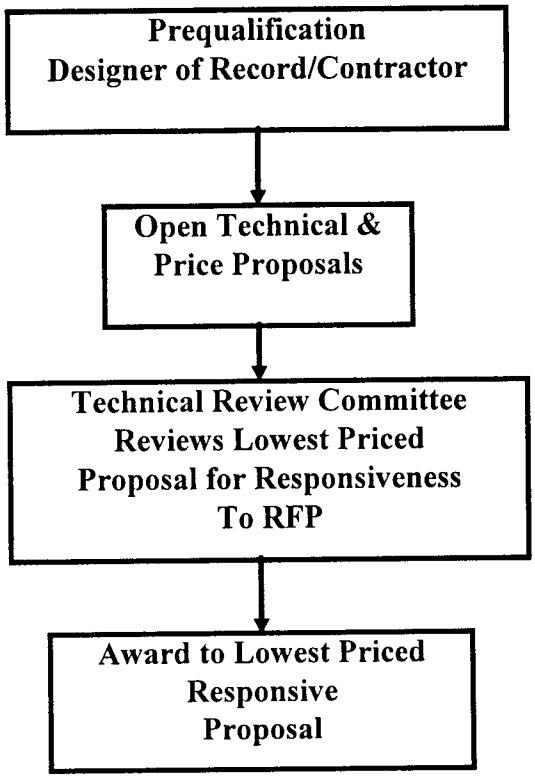
Figure 6: General Design-Build Evaluation Model



Low Bid Design-Build Evaluation Model

Under the low bid design-build (LBDB) process, the TxDOT will publicly open the price proposals on the day, time, and location noted in the announcement and send the technical proposals to the Technical Review Committee. Prior to acceptance of proposals, DB contractors are evaluated by current TxDOT prequalification procedures. The proposals are then opened and the TRC reviews the lowest priced proposal on the basis of design concepts and preliminary designs in order to compare the lowest priced proposal to the scope of services of the project. If the lowest priced technical proposal is found to be non-responsive, the TRC will then review the next lowest priced technical proposal to determine its responsiveness. A proposal is considered non-responsive if it does not contain all the information and level of detail requested in the RFP. It may be appropriate for the department to contact the non-responsive contractor to discuss or clarify its concerns prior to moving on to the next lowest bidder. The process will continue until the lowest priced, responsive proposal is found. The TRC then will notify the Contracts Administration Office of the contractor who submitted the lowest priced, responsive technical proposal. Unless all proposals are rejected, the department will award the project to the firm with the lowest responsive proposal and enter into a contract for the price proposed. Figure 7 is a flow chart which illustrates the flow of this process.

Figure 7: Low Bid Design-Build Evaluation Process



Adjusted Score Design-Build Model

Under the adjusted score design build (ASDB) process, the TRC will receive the technical proposals and the Contract Administration Office will hold all the sealed price proposals until the TRC provides the technical proposal scores. Each contractor's technical proposal shall be evaluated based on the rating criteria provided in the scope of services. The rating, or technical evaluation process, is extremely important and should use a fair and equitable method well understood by all members of the TRC.

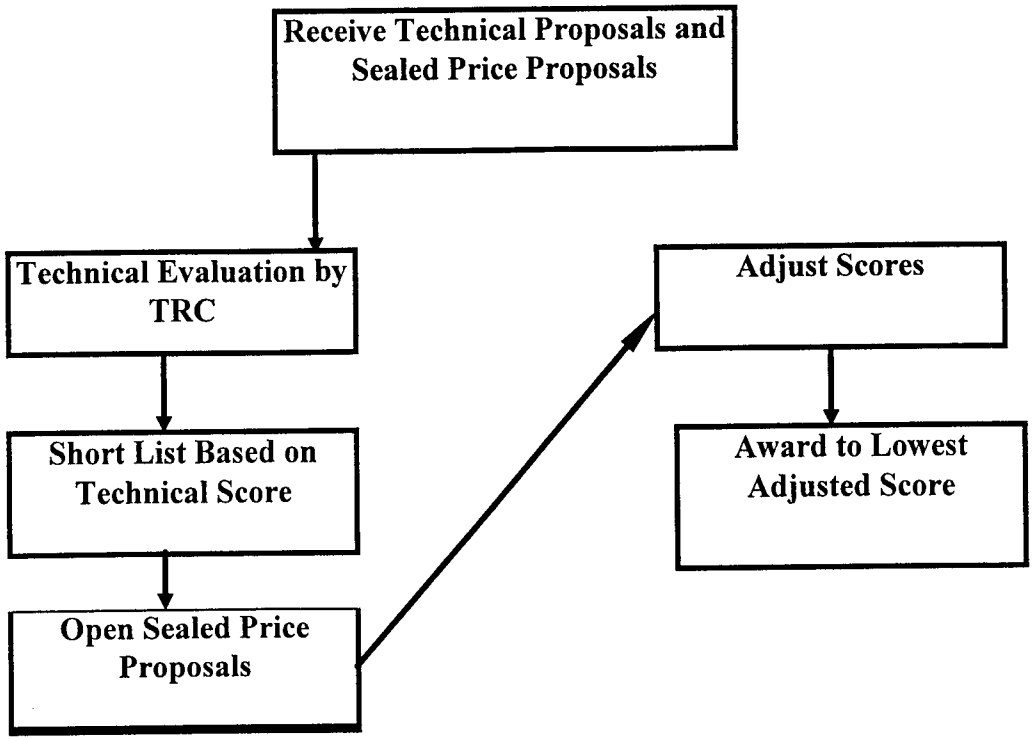
Upon completion of the technical evaluation, the TRC will submit a final technical score for each proposal to the Contracts Administration Office. During this technical review process, it is recommended that the team meet together to discuss their thoughts on each proposal. This should be a structured meeting to discuss concerns and determine how well each proposal met the scope. Rating points for each proposal should not be discussed at this meeting. The purpose of the meeting is to give each reviewer a better understanding of the technical merits of each proposal, not to develop a group score. At the conclusion of the technical review, the TRC will develop a short list of technically responsive and fully qualified DB contractors.

TxDOT will notify all short listed DB contractors of the date, time, and location of the public opening of the sealed bids. The sealed price proposals will then be publicly opened and the adjusted score will be determined by dividing each contractor's price by the score given by the TRC. The contract is then awarded to the DB contractor whose adjusted score is lowest. An example of how the selection formula would work is shown in Table 2 below. Figure 8 is a flow chart illustrating the ASDB process.

Table 3: Adjusted Score Design-build Example

FIRM	TECHNICAL SCORE	PRICE	ADJUSTED SCORE
A	90	$6.7 Million	74,444
B	80	$6.5 Million	81,250
C	70	$6.3 Million	90,000

Figure 8: Adjusted Score Design-Build Process



Best Value Design-Build

Best value design-build (BVDB) is different from ASDB in that the technical proposal and the price proposal are scored together, and the project price is one category. Each evaluation category is assigned a weight consist with the objectives of the project , and the score for each evaluation category is multiplied by its weight. The sum of the weighted scores in each category is the final score for each proposal. Upon completion of final score determination, the scores are arranged from lowest price to highest price, and the TRC must conduct a cost-technical trade-off analysis. The TRC must justify the selection of a proposal whose price is higher than the lowest proposed price by determining that the added increment of cost is offset by an added increment in value as measured by the evaluation plan. For example, if the cost difference between the lowest and second lowest proposals is 3%, then the difference in the weighted scores should be greater than 3% to justify expending the additional increment of cost. This example is merely a simplified version to illustrate BVDB and not intended to describe the total process. Each project is different and TxDOT should strive to develop a set of evaluation criteria that best describes the requirements for each project. In the example, TxDOT has determined that five evaluation categories are appropriate: Professional Qualifications, Price, Schedule, Traffic Control Plan, and Previous Experience (Table 3). Each category can receive a score from 0 to 5 depending on its quality. The prices are shown in Table 2. The weights, TRC scores, and weighted scores are shown in Table 3. The cost/technical trade-off analysis is shown in Table 4.

Table 4: Best Value Design-Build Example

Category	Weight	Firm A Score	Firm A Weighted Score	Firm B Score	Firm B Weighted Score	Firm C Score	Firm C Weighted Score
Prof. Qual	20	3	60	4	80	3	60
Price	25	3	75	3	75	4	100
Schedule	10	5	50	2	20	4	40
Traffic Control	25	3	75	3	75	3	75
Experience	20	3	60	5	100	2	40
Total	**100**		**320**		**350**		**315**

Table 5: Cost Technical Trade-Off Analysis for BVDB Example

Ranking	Price	Weighted Score	Price Increment	Score Increment
C	$6.3 Million	315	--	--
B	$6.5 Million	350	3%	+11%
A	$6.7 Million	320	3%	- 9%

From this analysis the TRC would recommend Firm B receive the award of the contract because the additional 3% of added cost is offset by 11% in added value as measured by the evaluation plan developed by the PA.

Value of Time Factor

Either type of design-build process may include a bid adjustment for the value of time. This adjustment will be based on the DB contractor's proposed number of days to complete the project multiplied by a value per day established by TxDOT.

The bid adjustment will be used for selection purposes only and shall not affect TxDOT's liquidated damages schedule or constitute an incentive or disincentive to the contract. TxDOT shall establish the cost per day value and include it in the RFP package. The DB contractor will determine the contract time necessary to perform all design-build functions. Using a zero base line, the DB contractor shall multiply its contract time by the cost per day contained in the RFP package. This value and the price proposal constitute the time adjusted price. Table 5 is an example of how this selection process would work using $2,000 per day:

Table 6: Value of Time Adjustment Example

Firm	Tech Score	Contract Time (Days)	Time Value (Days x $2K/day)	Price Proposal	Time Adjusted Price (Time Value + Bid Amount)	Adjusted Score (Time Adj Price/Tech Score)
A	90	300	$600K	$6.7 M	$7.3 M	81.111
B	80	250	$500K	$6.5 M	$7.0 M	87.500
C	70	400	$800K	$6.3 M	$7.1 M	101.428

In this example, under LBDB, Firm B would be awarded the contract based on the lowest time adjusted price. Under ASDB, the time adjusted price would be divided by the technical proposal score to determine the lowest adjusted score. In the above example, Firm A would be awarded the contract under ASDB.

If the value of time factor is used, it is recommended that an incentive/disincentive clause also be included in the contract with cost per day equal to the value of time factor amount. This will create a more level playing field and keep the DB contractors from "playing" with the proposed contract time.

Task 7, Development of the Specification for DB Contracting of Low-Volume Pavement Construction and Rehabilitation

This task involved writing the specifications for DB projects based on the DB Evaluation Model developed in Task 6. Work is complete and the specification is being published under separate cover.

Task 8, Development of the Implementation Plan

As it is currently impossible to implement DB contracting in TxDOT due to legal constraints, Task 8 was dropped from this project.

Task 9, Final Report

This is the final report.

FINDINGS/DISCUSSION

The major findings to date are summarized in the following list and discussed in details in the appendices to this report.

1. It is currently impossible to legally implement DB contracting on most public projects in the State of Texas.

2. TxDOT pavement construction and rehabilitation projects appear to be suitable to implement DB contracts. However, prior to implementation, important decisions need to be made on the following issues.

- Level of detail needed for the contractor's design submission
- Evaluation method for contractor's design
- How to relate material quality, quality control, and quality assurance procedures
- Acceptance criteria for the completed pavement

3. The pavement design software package, FPS-19, can be used as an effective design evaluation tool. FPS-19's ability to estimate design life and life cycle cost can be adapted to provide easily interpreted output information for a utility theory based evaluation model.

4. Only fifteen out of fifty state DOTs are currently using DB to procure highway and highway related projects, and the FWHA has approved DB projects in the following thirteen states: Alaska, Arizona, California, Colorado, Florida, Maine, Michigan, Minnesota, New Jersey, North Carolina, Ohio, South Carolina, and Utah (FWHA, 1996).

5. Four states in our survey who were not using DB have expressed an interest in using DB in the future, and many of those states are preparing plans to begin using DB.

6. Support for the use of DB can be found in the design and engineering community. However, construction contractors as represented by the AGC do not currently support the concept.

7. The Federal government has been using DB for nearly two decades with a geometric increase in its use in the past five years.

8. Based on experience at both Federal and State DOT level, there is a sufficient body of contract clauses, formats, and content to easily develop a model set of DB specifications for use in Texas.

9. DB is a viable method for procuring both design and construction services for public projects and promises to reduce life cycle cost, contract cost, and contract and project delivery time.

10. There are three commonly used methodologies for awarding DB contracts on transportation projects. These methods are Low Bid Design-Build, Adjusted Score Design-Build, and Best Value Design-Build. Each method has its own strengths and weaknesses.

11. The researchers have not found any evidence that the furnishing of standard construction guarantees and/or warranties adversely impacts a contractor's capacity to procure either bid or performance bonds. However, additional research needs to be done before this statement can be made definitively.

CONCLUSIONS AND RECOMMENDATIONS

The most definitive conclusion to date is that legislation must be introduced to enable TxDOT to accrue the potential benefits of DB contracting. Enacting such legislation will not be simple. Contacts with the State Board of Registration for Professional Engineers, the Texas Society of Professional Engineers, and the Consulting Engineers Council indicate that there is support for the concept among the design community. An interview with the Associated General Contractors of America's Austin office found distinct opposition to the idea among the contractors who would be expected to form partnerships with the designers and perform the work on a DB basis. This is not to mean that passing DB legislation would be impossible. The research team is not in a position to render a judgment either way.

Next, assuming that DB can be made legal at some point in time, there is a considerable amount of documentation and experience in the federal sector and state DOTs to make implementing this concept a straightforward affair. Standard contract language has been devised and tested. Forms and a format for developing requests for proposals are available. All this can easily be tailored for use by TxDOT. This project produced a document entitled "Recommended Guidelines for Design-Build Procurement and Administration" and published it under separate cover. This document is a synthesis of the best procedures and methods found in Arizona, Colorado, Florida, and Pennsylvania combined with similar material currently in use by the U.S. Army Corps of Engineers. The purpose of the document is to provide a foundation for developing the policy and procedures necessary to implement DB if and when it becomes legal and appropriate.

Finally, with the above discussion in mind, the major recommendation at this point in time deals with preparing the political road to permit the introduction of DB legislation in the next legislative session. Based on the results of the literature survey, DB promises to reduce both the cost and the time required to complete most highway construction projects. Therefore, it is in the best interests of the State to make this contracting mechanism available for future projects. TxDOT policy makers should investigate the potential for opposition and begin addressing the specific concerns of each interest group, and thereby, paving the way to the development of a legislative act which is both supportable and implementable. The experience of other states might help identify the salient feature of a DB program which satisfies the concerns of all involved.

With respect to the purely engineering aspects of evaluating contractor proposed pavement designs, the following recommendations are made.

1. The pavement rehabilitation design proposed by the contractor should be the preliminary design. Updates will be based on forensic investigations conducted in find causes of pavement failure.

2. The proposed design should be evaluated on a multitude of factors including constructability, total life cycle cost, traffic control plan, safety, and comparison with benchmark TxDOT design criteria.

3. Quality control and quality assurance (where applicable) will follow existing TxDOT procedures.

4. At this stage and until some experience with DB contracting is gained in TxDOT, the contractor should be guided by existing TxDOT materials specifications.

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APPENDIX A: Legal Review of Texas Department of Transportation Design-Build Contracting and a Comparison with Other States' Laws

The TxDOT General Counsel's Office was asked to prepare a brief concerning the state of the law regarding the procurement of design and construction services in the same contract. The paragraphs below is that brief as written by Joanne Wright, Associate General Counsel, Texas Department of Transportation.

Design-build Contracting in Texas

"A design/build," or "turnkey," construction contract is one in which a single contractor provides both the design and the construction of a facility for the owner. The owner presents the contractor with a general description of the facility to be built, and the contractor is responsible for designing the facility and building it within the parameters of the owner's description. Current Texas law does not provide a mechanism for the Texas Department of Transportation (TxDOT) to utilize this type of contract for the design and construction of highways.

"TxDOT's contracting procedures are directed by statute with the applicable statutes making a distinction between construction services and pre-construction services. Each type of service is governed by its own law, and the two laws conflict to the extent that they cannot be reconciled, precluding the possibility of combining both types of services into a single contract. A contract made in violation of a statute is void. *Mayfield v. Troutman,* 613 S.W. 2d 339,344 (Tex Civ. App--Tyler 1981, writ ref'd n.r.e.).

"Section 223.001 of the Transportation Code states, "The department shall submit for competitive bids each contract for the improvement of a highway that is part of the state highway system." Attorney General Opinion JM-282 (1984) outlines the distinction between contracts for construction and contracts for the planning of construction, holding that the former does not include the latter. Section 233.001, then, applies only to the actual construction of the highway. Pre-construction contracts require the services of professionals or consultants and are governed by the Professional Services Procurement Act, Chapter 2254 of the Government Code. See Op. Tex. Att'y Gen. No. JM-940 (1988).

"The provisions of the Engineering Practice Act, article 3271a, V.T.C.S., require that design work on a construction project be performed by a registered professional engineer. Section 19 of the Act prohibits the State from constructing a public work unless the plans and specifications and estimates have been prepared by a professional engineer and the engineering construction is executed under the direct supervision of a professional engineer. State agency procurement of engineering services is governed by §2254.003 of the Government Code, which requires that such contracts be awarded "on basis of demonstrated competence and qualifications" of the provider. In the same statute, the legislature goes a step farther than simply exempting professional services from the competitive bid requirement: "A government entity may not select a provider of professional services . . . or award a contract for the services on the basis of competitive bids." Any contract made, whether directly or indirectly, in violation of this statute

is void as against public policy (§2254.005, Government Code). See also, *State v. Steck,* 236 S.W. 2d 836 (Tex. Civ. App.--Austin 1951, writ ref'd).

"While neither the Engineering Practice Act §2254.001 of the Transportation Code requires that the plans and specifications be complete prior to the award of the construction contract, such requirement is implicit in the competitive bidding statute. There is a great deal of case law that gives credence to the theory that a contract is not competitively bid unless bidders are presented a completed set of plans and specifications on which to bid. *Headlee v. Fryer,* 208 S.W. 213 (Tex. Civ. App.--Dallas 1918, writ dism'd), involved a contract to build a county courthouse, with the county being subject to much the same competitive bid statute as TxDOT. The county provided tentative specifications with pencil sketches of floor plans and a drawing of the building provided by an architect for the contractors to bid on. The court, in holding the resultant contract void as violating the competitive bid statute, stated:

". . . it can hardly be denied there could and would be no bids received, at least in good faith, in the absence of some specifications of what the county required to be done or furnished by prospective bidders on a contract requiring the expenditure of such a large sum. That some step on the part of the county officials was contemplated is a necessary deduction from the act requiring them to submit all such contracts to competition. Certainly responsible contractors are not going to undertake the financial liability involved in so important a matter as constructing a county courthouse without first being precisely informed what is required by the county particularly when it is commonly known that intelligent bids are out of the question in the absence of such information. The most ordinary prudence would require in such cases considerable particularity."

"In *Superior Incinerator Co.of Texas v. Tompkins,* 37 S.W.2d 391 (Tex. Civ. App.--Dallas 1931). *aff'd* 59 S.W.2d 102(Tex. Comm'n App. 1933, holding approved), the court stated, "A competitive bidding statute is fundamentally violated where the bidder is asked to furnish plans and specifications, and an award made under such circumstances is void."
"The Texas Supreme Court, in *Texas Highway Comm'n v. Texas Ass'n of Steel Importers,* 372 S.W.2d 525 (Tex. 1963), cited with approval the following description of competitive bidding stated in *Sterrett v. Bell,* 240 S.W.2d 516, 520 (Tex. Civ. App.--Dallas 1951, no writ):

"'Competitive bidding' requires due advertisement, giving opportunity to bid, and contemplates a bidding on the same undertaking upon each of the same material items covered by the contract upon the same thing. It requires that all bidders be placed upon the same plane of equality and that they each bid upon the same terms and conditions involved in all the items and parts of the contract, and that the proposal specify as to all bids the same, or substantially similar specifications."

"Therefore, TxDOT does not have the authority to award a design/build highway improvement contract by competitive bid if such contract will include engineering services. Likewise, §2254.002 of the Transportation Code prohibits award of a contract through the Request for Proposal process if it will include the construction of improvements to the highway system.

Because the two statutes contain mutually exclusive contracting requirements, TxDOT is without legislative authority to enter into design/build contacts."

Design-Build Contracting in Other States

Laws across the the United States vary with respect to the use of DB to procure public projects. In fact, Texas is currently operating on an exemption to the laws discussed by Wright for school districts.

APPENDIX B: Design Build Best Practice Survey

The study team prepared and issued two surveys to various state and federal agencies to identify existing "Best Practices" in this area. The first survey was a preliminary survey whose purpose was to identify those states with current DB experience and obtain the name of the person who had the most comprehensive knowledge in each agency. This approach had been used successfully by the team in a previous TxDOT research project. The second survey was a detailed questionnaire and was sent directly to the point of contact named in the preliminary survey. At this writing, the responses to the second survey are not complete. Therefore, only emerging data is available for discussion in this report. Additionally, a copy of a nationwide survey on DB conducted by the Design-Build Institute of America (DBIA) was obtained (DBIA, 1996). This study helps put the results of the survey of DOTs in perspective. Before the details of our surveys are presented, it will be helpful to discuss the DBIA survey and allow it to establish the national context in which we must analyze the data we obtained.

In 1996, DBIA surveyed the Offices of the Attorneys General of all fifty states and the District of Columbia. The overall purpose of the study was to "benchmark the acceptance and use of alternative and innovative contracting methods permitted by state governments (DBIA, 1996)." There were twenty-seven states which reported that DB was a permissible procurement mechanism. Only nine states had laws which expressly forbade DB. Interestingly, Texas was not among those nine. Of the states which did not permit DB, four reported that it was possible to use a DB subcontractor, and Texas was one of those. Forty-five states reported that they are required to select architect/engineer services on a qualifications-bases process, and forty-eight states stated that they were required to award construction contracts which do not include design by competitive bids. Finally, tweenty-nine states reported that they employ contracting methods other than design-bid-build (DBB) to procure projects. Texas was not among that group. It is also interesting to note that the information reported by the Texas Attorney General's Office appears to conflict with that found by the TxDOT General Counsel's Office. We attribute this discrepancy to a less than accurate response by the Attorney General's Office. Additionally, the TxDOT response was a documented brief rather than a questionnaire response; therefore, the writer was directly focused on the specific application of DB in the Department rather than a broad, all-encompassing Yes/No response to the use of DB throughout the state in both private and public projects.

When this information is taken along with information collected by the FHWA, an interesting picture emerges. Only thirteen out of fifty state DOTs are currently using design-build to procure highway and highway related projects, and the FWHA has approved DB projects in the following thirteen states: Alaska, Arizona, California, Colorado, Florida, Maine, Michigan, Minnesota, New Jersey, North Carolina, Ohio, South Carolina, and Utah (FHWA, 1996). The geographic dispersion of the states who have adopted DB covers virtual the entire country. No specific region seems to either espouse or reject DB. The experience of the Federal government is also cogent to this discussion. The Department of the Navy reported a 15% savings in DB project cost and a 12% reduction in facility delivery time over DBB projects. The Department of Defense Nonappropriated Fund projects showed savings of 18% in costs and 14% in time (DBIA, 1996). Obviously, some state DOTs are seeking to accrue benefits similar to those

realized by federal engineering agencies. Now let us take a look at the use of DB in state DOTs as measured by this study's survey.

Table B-1: Results of Design-Build Preliminary Survey

State	Question 1	Question 2	Question 3	Question 4	Question 5	Additional Information
Alabama	Yes	2 projects	No		Yes	Useful on unusual or extremely fast-track projects
Alaska	Yes	< 1%	Yes	Loren Rosmusson	Maybe	(907) 465-6958
Arizona	Yes	0%	N/A	Ron Williams	Yes	(602) 255-7707 Working on two pilot projects
Arkansas	No	N/A	N/A	Robert Walters	No	(5 01)569-2000
California						
Colorado	Yes	2 projects	Yes	Ken Mauro	Yes	
Connecticut	Yes	None	No	Earle Munroe, PE	No	(860)594 31 S0
Delaware	No	N/A	N/A		No	
Florida	Yes	Yes		Greg Xanders	Yes	(904)48 8-6721
Hawaii	No	N/A	N/A	Francis Nishioka	No	
Idaho	No	N/A	N/A	James D. Porter	Maybe	(208)334-8495 Just received permission to utilize DB
Iowa	Yes	None	N/A	David Little	No	(515)239-1402 IaDOT did one project in 1982
Kansas	No	N/A	N/A	David Comstock PP.	No	(913)296-1568 Would like a copy of final report
Kentucky	No	N/A	N/A	J M Yowell, PP	No	*Would like copy of final report
Louisiana	No	None	No	William Hickey	No	(504)167-9108
Maine						
Michigan						
Mississippi	No	N/A	N/A		No	
Montana	No	N/A	N/A		No	
Nebraska	No	N/A	N/A	Claude Oie	No	(402)479-4532
Nevada	No	None	N/A	Susan Martinovich	No	(702)888-7440 'Would like ~ copy of report
New Jersey						
New York	No	N/A	N/A		No	Currently seeking legislation to allow maintenance paving
North Carolina	Yes	I project	Yes	Robert Canales, PP.	Yes	(919) 250-415 I
North Dakota	No	N/A	N/A		No	
Ohio						
Oklahoma	No	None	No		No	Not interested in D/B
Pennsylvania	Yes	8	Limited	MG. Patel, PK.	Yes	
South Carolina						
South Dakota	No	None	N/A	Tim Bjorneberg, John Cole, or Lawrence Weiss	No	(605)773-3174 Possible attempt at future projects.
Utah	No	N/A	N/A	PK Mohanty, PP.	Yes	(801)9654000 Awarding first DIB project in March
Virginia	No	N/A	N/A	Robert Edwards	No	*Would like copy of final report
Wyoming	No	N/A	N/A	Gary Carver	No	*Would like copy of final report

Questions

1. Has your department ever used design-build for any of its construction work?

2. If so, approximately what percentage of projects were contracted using design-build over the past 5 years?

3. In your opinion, was the design-build method beneficial to your construction projects?

4. Who is the point of contact for design-build in your department?

Note

Any state that has no entries are either non responsive or have not submitted there response.

BEST PRACTICE SURVEY

In order for us to determine what the state of design-build contracting is in the United States, we have done a survey to find out more information. Two surveys were conducted. The purpose of the first survey was to find out which states were using the DB method of contracting. The second survey was conducted for those states that were using the DB method of contracting. In addition to this we have learned that The Design Build Institute of America has recently concluded a survey of all fifty states.

The first survey was sent out in late Fall 1997. A copy of this survey can be found in Tab 1. This survey was general in nature and was mainly conducted to determine which states use the DB method of contracting. Then we could send a more detailed survey to those states that do use DB contracting.

- Of the fifty states, thirty-three responded to the questionnaire.
- Of the thirty-three respondents, nine responded that they had used D-B on some projects - Alabama, Alaska, Arizona, Colorado, Connecticut, Florida, Iowa, North Carolina, and Pennsylvania.
- Out of those nine states, five said they thought the method was beneficial to their construction projects - Alaska, Colorado, Florida, North Carolina, and Pennsylvania.
- Five states requested a copy of our report when it is completed - Kansas, Kentucky, Nevada, Virginia, and Wyoming.

The second survey was sent out in February. A copy of this questionnaire can be found in Tab 2. As of this date not all the surveys have been responded to. The survey was sent to - Alabama, Alaska, Arizona, Colorado, Connecticut, Florida, Iowa, North Carolina, and Pennsylvania. The four states that have responded are: Arizona, Colorado, Pennsylvania, and Utah. The results of the survey can be found in Tab 3.

Emerging results of questionnaire #2 are as follows:

1. The majority of respondents have done less than 5 DB projects. Arizona, Colorado and Utah. Pennsylvania have done the most projects, 5-20.
2. Arizona and Colorado have been using DB for 3-5 years
   Pennsylvania has been doing DB projects for more than 5 years.
   Utah has just awarded their first DB project and is currently working on another D-B project.
3. The value of the projects ranged from $300,000 - $1.33 billion with an average value of $336,625,000.
   Colorado has the lowest value at $300,000 and Utah has the highest value at $1.33 billion.
4. Arizona uses a statement of qualifications and technical proposal as their format for request for proposal (RFP) .
   Pennsylvania uses 20-30% preparation of plans and permit approval as a basis for RFP.
   Information on RFP for Colorado and Utah was unavailable.
5. The majority of states require a technical proposal for proposal submission.

6. All states have a formal proposal evaluation plan evaluated mainly on: Milestones (proposed schedule),Contractual experience, Design approach, Cost, Quality Control, Financial data of company, and Safety and Traffic Control
7. The majority of states pre-qualify proposals. Companies are pre-qualified based on experience, qualifications, and bonding capacity.
8. Two states award final DB contracts without negotiations, Arizona and Colorado. Pennsylvania awards contract on low bid basis. Utah negotiates to receive best and final offers.
9. The majority of states listed the main factors in selecting DB contracts over DBB contracts as:
   Need to fast track to achieve fixed delivery date Reduced project delivery period
   Constructability considerations will drive design concept
   Constructability considerations will drive design details
   100% design not required to permit high quality product
   Risk and costs can be shared to reduce overall cost.
10. Pennsylvania and Utah list reduced cost as the major advantage of DB contacts. While Arizona and Colorado list project completion time as the main advantage.
11. Arizona lists less control of final design as the major disadvantage of DB. Colorado lists increased risks as the major disadvantage and the other two states were non-responsive.
12. In comparing DB vs. DBB all states agree that DB is faster and most agree that it generates value engineering.
13. Three out of the four states use DB on major rehabilitation and bridge projects. While two states use DB on new highway projects.
14. Two states have limited use of DB in regards to their laws and one state has unlimited use.
15. Three out of four states have a standard set of clauses for DB projects.
16. Three states have had the contractor organized as the general contractor with a design subcontractor. Utah has had the contractor organized as a joint venture between general contractor and the Architect/Engineer.
17. In administering DB contracts all departments of transportation approve final design, submittals, pay estimates & quantities and quality control test results.

Tab 1: Original Questionnaire

1. Has your department ever used design-build for any of its construction work?

2. If so, approximately what percentage of projects were contracted using design-build over the past 5 years?

3. In your opinion, was the design-build method beneficial to your construction projects?

4. Who is the point of contact for design-build in your department?

Tab 2: Questionnaire #2

1. How many projects, to date, have used design/build as the method of contract?

None Less than 5 5-20 greater than 20

2. How many years has your state used design/build as a method to contract highway projects?

1-2 years 3-5 years more than 5 years

3. What is the dollar value of the projects that have used design/build?

Smallest_____ Largest_____ Average _____ _____

4. What is your format for design/build request for proposal? Would you please send us a copy of a typical RFP?

5. What format do you require for proposal submission?

6. Do you prepare a formal proposal evaluation plan? If so, please send us a copy of a typical plan.

Yes No

If so, what areas do you typically evaluate?

____Milestones (proposed schedule)
____Contractual experience
____Design approach
____Cost
____Quality Control
____Financial data of company
____Safety
____Environmental Protection Plan
____Traffic Control
____Other (specify)_____.

7. Do you pre-qualify proposals? Yes No

8. How are companies pre-qualified?

____Experience
____Qualification
____Bonding Capacity
____Other (specify)_____.

9. How are the final design/build contracts negotiated?

____Award without negotiations
____Negotiate and receive best and final offers

____Other (specify)_____.

10. What factors would cause you to select design/build as the contracting instrument rather than design-bid-build for given project? Mark all that apply.

____Need to fast track to achieve fixed delivery date
____Reduced project delivery period
____Constructability considerations will drive design concept
____Constructability considerations will drive design details
____100% design not required to permit high quality product
____Risk and costs can be shared to reduce overall cost.
____A single point of responsibility is required for the life of the project
____Owner/designer must rely on builder to supply best technology/lowest cost matrix
____Unique factors about project location require special knowledge or experience to produce least cost design.
____Other (Specify)_____.

I 1. What is the principle advantage and disadvantage, from your point of view, of using design/build contracts?

Advantages: (mark one only)
____Project completion time
____Reduce cost
____Single point of responsibility
____Other_____.

Disadvantages: (mark one only)
____Less control on final design
____Legal situation less clear
____More front-end contract preparation work
____Higher potential for award protest
____Other_____.

12. Would you give a comparison of design/build vs. Design-bid build contracts. (check all that apply)

____D/B is faster
____D/B is less expensive
____D/B has less claims
____D/B generates value engineering

3. On what types of projects do you use design/build? (check all that apply)

____new highway
____maintenance
____buildings
____major rehab projects
____bridge
____traffic signals/devices

4. What are the state laws regarding design/build contracting for public works projects?

____prohibit ____allow limited ____unlimited

15. Do you have a standard set of contract clauses for design/build projects? (If yes, would you send us a copy) Yes No

16. What is the average project delivery time from authorization of funding to substantial completion of actual project.

Design/build project _____ months.

Design-bid-build project _____ months.

17. In past design/build projects, how has the contractor been organized?

____General contractor with design subcontractor
____Joint venture between general contractor and Architect/Engineer
____Architect/engineer as prime with builder as subcontractor
____General contractor with in house design capability.
____Other_____.

18. In administering design/build contracts who approves;

Final design	____DOT	____Designer
Submittals	____DOT	____Designer
Pay estimates & quantities	____DOT	____Designer
Quality control test results	____DOT	____Designer

Tab 3: Emerging Results of Questionnaire #2

Arizona

1. How many projects, to date, have used design/build as the method of contract?
   Less than 5

2. How many years has your state used design/build as a method to contract highway projects?
   3-5 years

3. What is the dollar value of the projects that have used design/build?
   Smallest 1.8 Million Largest 3 Million Average 3-4 Million

4. What is your format for design/build request for proposal?
   Statement of Qualifications(SOQ) and Technical proposal

5. What format do you require for proposal submission?
   SOQ and Technical proposal

6. Do you prepare a formal proposal evaluation plan?
   Yes
   If so, what areas do you typically evaluate?
   - Milestones (proposed schedule)
   - Contractual experience
   - Design approach
   - Quality Control
   - Financial data of company
   - Safety
   - Traffic Control
   - Cost

7. Do you pre-qualify proposals?
   Yes

8. How are companies pre-qualified?
   Experience, Qualification, and Bonding Capacity

9. How are the final design/build contracts negotiated?
   Award without negotiations

10. What factors would cause you to select design/build as the contracting instrument rather than design-bid-build for given project?
    - Need to fast track to achieve fixed delivery date
    - Reduced project delivery period
    - 100% design not required to permit high quality product
    - Risk and costs can be shared to reduce overall cost.
    - Use of innovative (private) financing

11. What is the principle advantage and disadvantage, from your point of view, of using design/build contracts?

Advantages: Project completion time
Disadvantages: Less control on final design

12. Would you give a comparison of design/build vs. Design-bid-build contracts.
    D/B is faster

13. On what types of projects do you use design/build?
    new highway, major rehab projects, and bridges

14. What are the state laws regarding design/build contracting for public works projects?
    allow limited

15. Do you have a standard set of contract clauses for design/build projects?
    Yes

16. What is the average project delivery time from authorization of funding to substantial completion of actual project?
    Design/build project 15 months
    Design-bid-build project 18 months

17. In past design/build projects, how has the contractor been organized?
    General contractor with design subcontractor

18. In administering design/build contracts who approves?
    DOT approves all:
    Final design.
    Submittals.
    Pay estimates & quantities. and
    Quality control test results.

Colorado

1. How many projects, to date, have used design/build as the method of contract?
   Less than 5 2.

2. How many years has your state used design/build as a method to contract highway projects?
   3-5 years

3. What is the dollar value of the projects that have used design/build?
   Smallest $300~000 Largest $30 Million Average over $10 Million

4. What is your format for design/build request for proposal?

5. What format do you require for proposal submission?
   Low bid and Technical proposal

6. Do you prepare a formal proposal evaluation plan?
   Yes. we use a committee to evaluate proposals to assure they meet minimum contract requirements.
   If so, what areas do you typically evaluate?
   no response

7. Do you pre-qualify proposals?
   Yes

8. How are companies pre-qualified?
   Experience,
   Qualifications,
   Bonding Capacity, and
   Standard state list for DOT

9. How are the final design/build contracts negotiated?
   Award without negotiations - lump sum bid

10. What factors would cause you to select design/build as the contracting instrument rather than design-bid-build for given project?
    Need to fast track to achieve fixed delivery date
    Reduced project delivery period
    Constructability considerations will drive design concept
    Constructability considerations will drive design details
    100% design not required to permit high quality product

11. What is the principle advantage and disadvantage, from your point of view, of using design/build contracts?
    Advantages: Project completion time
    Disadvantages: Legal situation less clear - more risk

12. Would you give a comparison of design/build vs. Design-bid build contracts.
    D/B is faster and generates value engineering

13. On what types of projects do you use design/build?
    major rehab projects and bridges

14. What are the state laws regarding design/build contracting for public works projects?
    allow limited

15. Do you have a standard set of contract clauses for design/build projects?
    Yes

16. What is the average project delivery time from authorization of funding to substantial completion of actual project.
    Response: Varies

17. In past design/build projects, how has the contractor been organized?
    General contractor with design subcontractor

18. In administering design/build contracts who approves?
    DOT approves all
        Final design
        Submittals
        Pay estimates & quantities
        Quality control test results

Pennsylvania

1. How many projects, to date, have used design/build as the method of contract?
   5 - 20

2. How many years has your state used design/build as a method to contract highway projects?
   more than 5 years
3. What is the dollar value of the projects that have used design/build?
   Smallest $500,000 Largest $5 Million Average $1 Million

4. What is your format for design/build request for proposal?
   Prepared 20-30% of plans, secured all permits, and cleared R/W

5. What format do you require for proposal submission?
   Same as above

6. Do you prepare a formal proposal evaluation plan?
   Yes

7. Do you pre-qualify proposals?
   No

8. How are companies pre-qualified?
   Experience, Qualifications, and Bonding Capacity

9. How are the final design/build contracts negotiated?
   Low bid

10. What factors would cause you to select design/build as the contracting instrument rather than design-bid-build for given project?
    Low bid

11. What is the principle advantage and disadvantage, from your point of view, of using design/build contracts?
    Advantages: Project completion time, Reduce cost, and Single point of responsibility

Disadvantages: If design can be completed while securing permits and clearing R/W, then D-B has no advantage.

12. Would you give a comparison of design/build vs. Design-bid-build contracts.
    N/A

13. On what types of projects do you use design/build?
    Bridges

14. What are the state laws regarding design/build contracting for public works projects?
    We had to be extremely careful in meeting the state law requirement which indicates that the department is responsible for providing plans and specs in sufficient detail to ensure that a common base for bidding is established.

15. Do you have a standard set of contract clauses for design/build projects?
    Yes

16. What is the average project delivery time from authorization of funding to substantial completion of actual project.
    Varied

17. In past design/build projects, how has the contractor been organized?
    General contractor with design subcontractor

18. In administering design/build contracts who approves?
    DOT approved all
    - Final design
    - Submittals
    - Pay estimates & quantities
    - Quality control test results

Utah

*note - We are just about to award our first design/build contract (major rehab). We are currently in the planning stages on a second project (new highway).

1. How many projects, to date, have used design/build as the method of contract?
   less than 5

2. How many years has your state used design/build as a method to contract highway projects?
   1-2 years

3. What is the dollar value of the projects that have used design/build?
   $1.33 Billion

4. What is your format for design/build request for proposal?
   A copy (on CD) was provided to TxDOT - a set can be purchased by contacting Scott Palmer at (801)288-3231

5. What format do you require for proposal submission?
   N/A

6. Do you prepare a formal proposal evaluation plan?
   Yes

If so, what areas do you typically evaluate?
   Milestones (proposed schedule)
   Contractual experience
   Design approach
   Cost
   Quality Control

7. Do you pre-qualify proposals?
   Yes

8. How are companies pre-qualified?
   Experience, Qualifications, and Bonding Capacity

9. How are the final design/build contracts negotiated?
   Negotiate and receive best and final offers

10. What factors would cause you to select design/build as the contracting instrument rather than design -bid-build for given project?
   Need to fast track to achieve fixed delivery date
   Reduced project delivery period
   Constructability considerations will drive design concept
   Constructability considerations will drive design details
   100% design not required to permit high quality product
   Risk and costs can be shared to reduce overall cost.
   A single point of responsibility is required for the life of the project
   Owner/designer must rely on builder to supply best technology/lowest cost matrix
   Unique factors about project location require special knowledge or experience to produce least cost design.

11. What is the principle advantage and disadvantage, from your point of view, of using design/build contracts?
   Advantages: Reduce cost
   Disadvantages: N/A

12. Would you give a comparison of design/build vs. Design-bid-build contracts?

D/B is faster, has less claims, is less expensive, and generates value engineering

13. On what types of projects do you use design/build?
    new highway and major rehab projects

14. What are the state laws regarding design/build contracting for public works projects?
    Unlimited

15. Do you have a standard set of contract clauses for design/build projects?
    No

16. What is the average project delivery time from authorization of funding to substantial completion of actual project?
    Expect 41/2 years on current project

17. In past design/build projects, how has the contractor been organized?
    Joint venture between general contractor and Architect/Engineer

18. In administering design/build contracts who approves?
    DOT approves all
    - Final design
    - Submittals
    - Pay estimates & quantities
    - Quality